肆、加拿大綠色能源概況

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一、 前言：

根據產業專家表示，綠色能源產業範圍十分廣泛，包含「綠色」和「可再生」能源的概念。廣義而言是指使用高級技術所制造的非傳統資源形式的能源，包括新能源的發展，制造，傳輸，存儲和相關的最終使用產品。加拿大綠色先進能源產業，主要屬於可持續性能源與再生能源，包括氫氣和燃料電池，動力技術，生物能源以及可選擇能源（如太陽能，風能和海洋能）。

產業專家表示，投資於綠色能源是減少溫室氣體排放並改善環境的主要辦法之一。加拿大政府及加拿大自然資源部（Natural Resources Canada）不斷致力於綠色能源，持續在加拿大各地推動實際的計畫，其中全球第一個混合動力燃料電池計畫即為顯例。加拿大政府的經濟行動計劃，總計約有 24 億加元，目的係幫助加拿大創造更清潔，永續發展的環境目標，甫於 2010 年 1 月 11 日宣佈投資再生能源計畫，將創造就業機會，改善環境並振興經濟。包括將運用規模高達近 10 億加元之清潔能源基金（the Clean Energy Fund）支持 19 個計畫，這些計畫的總投資金額高達 1 億 4 千 6 百萬加元，在加拿大各地推動再生能源和清潔能源，包括社區能源整合解決方案、智慧網技術、再生能源應用如太陽能、風力發電、海洋潮汐能，以及地熱能，預估將實質助益加拿大清潔能源技術的發展，同時為加拿大人創造高品質的工作。

據專家表示，加拿大政府經濟行動計劃中的清潔能源基金，在短期間創造出新的經濟活動，同時為往後的永續榮景奠定了基礎。據了解，清潔能源基金投資近 10 億加元於技術開發和示範。清潔能源基金投資的各種大小型示範計畫的槓桿效應，為加拿大經濟創造出包括來其他各級政府及產業的投資達到近 35 億加元的利益。

二、 加拿大整體綠色產業概況

產業專家就加拿大綠色能源產業發展概分為下列項次：

（一）生質能源

加拿大為世界上早期致力於生質能源研究開發的國家之一，目前亦為主要生質能源研發的領導國。由於加拿大為聯合國會員國成員，為配合聯合國於 2005 年 2 月氣候變遷會議所簽訂之京都議定書(Kyoto Protocol)，議定書內容要求世界各國應在 2008 年至 2012 年間，將二氧化碳、甲烷、氧化亞氮、全氟碳化物、氫氟碳化物及六氟化硫等六種溫室氣體排放量，平均減少至比 1990 年排放量要低 5.2% - 6%之水準。目前加拿大主要的生質能量來源，主要有兩類，第一種是原生質物料(Raw biomass), 第二種是次生質物料(Secondary biomass)，主要原因是加拿大領土廣闊，擁有豐沛的廣大林區。

原生質物料主要係指從森林中取得之樹木及矮灌木等，以及穀類作物如草桿，豆科植物、油菜籽、玉米穀物及燈心草等植物材料；或者是水中的物質像是各種的海草或海藻類等，甚至是利用動物的排泄物。原生質物料亦指一些特別種植用來做為生物能源的能源作物，典型的能源作物有混種的白楊屬植物、柳樹、軟草類植物以及蘆葦科植物等。次生質物料係指所有來自於原生質物料的物質但還未經過重大的化學或物理變化，例如紙張或厚紙板、動物皮革、紙漿、棉花、紡布、麻纖維、天然橡膠產品、分子聚合包裝物、廢棄食用油，以及乳酪乳漿等。除此之外，在加拿大另一種生質能的主要來源是，產品加工製造時所剩下的殘餘物，最常見的是森林的廢料，如鋸木廠所剩的殘削、樹皮、木條、木屑等；造紙廠所殘留的紙漿等相關廢料等。農業的殘留物，如牛、豬、羊、雞、鴨等牲畜的排泄物，穀物的殘渣如稻秣、米糠等穀物殼屑，乾草、秣草以及麥桿等。食物加工的殘餘物，如：罐頭食品廠的廢棄、果屑以及研磨咖啡煮後所殘留的殘渣等；最後，都市的廢棄物，如紙張、厚紙板、橡膠、皮革、天然紡織品、木材、割草後的草料、廚房廢棄物以及下水道廢物等。這些都是加拿大政府用來做為生質能源的原料來源。

加拿大主要的生質能源來自於廣大的森林地、農業作物以及都市廢棄物之利用。其中數百萬公頃有效管理的森林地，僅很小部分的林地被用以作木製產品加工，依據營養平衡的評估實驗顯示，加拿大的森林廢料提供燃料絕佳來源，不會影響森林生態系統，反而因森林廢料被有效再利用後，可以釋放出更多的土地種植新樹林。

在農業方面，加拿大草原省包括曼尼托巴、薩斯卡奇萬的穀類作物，據估計每年可生產數百萬公噸的乾草廢棄物，除大部分被利用製造傳統農業肥料外，仍有為數可觀的乾草可以用來做生物能源燃料。專家表示，在 19 世紀末期的加拿大，儘管當時土地貧瘠，許多加拿大的土地仍被用來耕種。如今，現代農業科技的進步，這些土地已經不再耕作，加拿大政府將利用這些地區來做為種植生物能源的作物，這些作物通常成長迅速且高利潤。例如由玉米或向日葵等植物的種子所產生植物油，可以用來製造純淨的生物柴油，最直接的方法就是用機器從植物種子中萃取出油脂，生物柴油已被證實可實質運用於車輛的燃料。另外，利用菌種製造氣體，當動物的排泄物或垃圾廢棄物被細菌所消化，而產生出生物氣體，其可替代作為天然氣的使用。

加拿大政府目前朝向有效地利用各類能源資源，加以政府政策鼓勵生質能源的研發，強調科技與資源同時並存時，必須不影響食物生產及傳統產品的製造。如果加拿大可以有效利用各項資源，而不是將它們丟棄掉。例如加拿大每年製造出數百萬公噸的都市廢棄物，這些廢棄物將產生重要的能源影響，並且達到京都議定書中，降低溫室氣體的目標。目前加拿大生質能源開發利用的政策，主要是結合生活之應用。除了利用它廣大的森林及農業的廢棄物之外，它還利用植物的種子製造柴油、菌種製造燃料氣體、利用生質能量的燃燒氧化產生氣體，用於商業及工業的設備設施，及廣及於住宅區的熱暖氣系統。據了解，在加拿大的飯店，大型賣場、公寓大樓、以及醫院、學校等等大型建築物，都是使用熱燃燒氧化系統；而較小型的機構則通常燃燒木屑、木塊、樹皮等來加熱使用水，並將熱氣傳送到建築物的其他區域；

較大的機構如醫院等，則是使用低壓蒸氣系統，來當作建築物的暖氣系統、洗衣房以及食物的準備利用。

至於對住宅居家的能源供應，在加拿大的郊區及鄉間仍然持續使用燃燒木柴的傳統方式。加拿大人很享受用木材燃燒所帶來的溫暖舒適感。但是燃燒木材在今天的加拿大是否為一有效率的能源方式？對超過 300 萬的加拿大家庭而言，答案仍是肯定的。全加拿大仍有超過 300 萬個家庭是使用木材燃燒來當作能源使用，對家庭而言，不但節省了燃料費用的支出，人民也享受到更有家庭溫馨感。雖然木材是可再生能源，可以降低整體的 GHG 輻射量，但仍會造成空氣污染。當燃燒未完全，像是在悶燒的狀態下，濃煙的密度充滿微物粒子和有毒的氣體。然而，隨著家庭爐灶及煙囪的進化與改良，家庭使用燃燒木材對造成環境溫室輻射的污染程度並不嚴重。

（二）水力發電

產業專家表示，水力發電產業釋放的溫室效應氣體在所有發電設備中最少，比原煤發電廠低 60 倍，比天然氣發電廠低 18-30 倍，並且不產生任何其他氣體污染物。 綜合這些優勢再加上水力發電的高產能儲存量，水能發電成為了支持可再生能源如風力發電及太陽能發電的最好的資源。水力發電產業釋放的溫室效應氣體在所有發電設備中最少，比燃煤發電廠低 60 倍，比天然氣發電廠低 18-30 倍，並且不產生任何其他氣體污染物。 綜合這些優勢再加上水力發電的高產能儲存量，水力發電成為了支持可再生能源如風力發電及太陽能發電的最好的資源。根據加拿大水力發電協會(Canadian Hydropower Association)結合國際水力發電協會(International Hydropower Association)及國際電力組織(International Energy Agency)，共同撰寫一份名為「水力發電與全球能源的未來」之報告中宣稱水力發電「提供主要的乾淨和再生能源，並且在未來全球多樣化能源中扮演關鍵性角色。」

加拿大在水力發電領域在世界上居領導地位，設備產能超過 70,858 兆瓦（MW），年均產量為 350 太瓦-小時（TWh）。 在技術上，目前仍然有另行建立 118,000 兆瓦的水力發電設備的空間——大約是目前運轉量的兩倍。全加合計約 475 家水力發電廠，是加拿大歷史最悠久也是最完善的「綠色」產業。 水力發電占加拿大全部可再生能源發電量的 97%，並占全球水力發電量的近 13%。

加拿大擁有世界上最高的水力發電量，為世界之冠。目前水力發電總裝機容量已達 0.67 億千瓦，有 804 座大壩，其中 596 座大壩以發電為主，有 211 個水力發電廠，發電量 3530 億度。水力發電在加拿大佔有重要的地位，目前全國電力 70%以上來自水力發電，且有多余的電力輸送到美國，除愛德華王子島省外其他省區都有

些水力發電，數量最多的在魁北克省、不列顛哥倫比亞、紐芬蘭和拉布拉多、曼尼托巴和安大略省。

（三）氫能源與燃料電池

根據產業專家預測，到 2010 年前，世界每天生產的氫能源當量將相當於 320 萬桶石油；2020 年前將相當於 950 萬桶石油。專家們認為，氫能可能會在 2050 年前取代石油而成為主要能源，人類將進入完全的氫經濟社會。燃料電池的原理是利用電分解水時的逆反應，使氫氣與空氣中的氧氣產生化學反應，產生水和電，從而實現高效率的低溫發電，且餘熱的回收與再利用也簡單易行。氫能源因其潔淨性與可儲存性讓先進國家基於能源安全與環境永續發展而積極投入。目前氫能源的利用主要是透過燃料電池裝置來使化學能變成電能，其應用涵蓋分散式發電系統、運輸載具與可攜式 3C 產品。

加拿大一直致力於維持其在全球燃料電池和氫能工業中的主導地位，有許多燃料電池合作組織和計畫以及擁有一些處於世界領先地位的燃料電池和氫能企業。根據產業專家表示，加拿大氫能經濟產業鏈包括：氫能研發、氫燃料電池、氫燃料電池驅動系統、制氫、加氫、加氫站建設等。加拿大國家研究院的燃料電池創新研究所 (Canada’ s Institute for Fuel Cell Innovation, NRC-IFCI) 是加拿大在燃料電池和氫能產業中首屈一指的應用研究組織。相關研究重點包括：移動式、可攜式、固定式燃料電池的應用；先進材料和氫能的存儲；無廢氣排放的氫能產品；氫氣運輸、燃料體系和基礎設施；規範與標準、檢測方法和參數及對社會、經濟和環境的影響。NRC-IFCI 是獨立運作並與各大學、政府機構和公司進行合作計畫，著重於研究、開發、展示和測試氫能及燃料電池系統。該研究所的任務為提供加拿大政府對於加拿大燃料電池商業化的趨勢變化和創新優先事項及關鍵性的研究領域等方向策略性規劃。NRC-IFCI 的研究發展計畫其目的是推進燃料電池科學和技術，並加速這些技術的商品化。加拿大氫能和燃料電池技術在全家國均有擴展中心，如溫哥華，卡加利，多倫多，京士頓，蒙特婁。根據加拿大氫燃料電池和燃料部門報告顯示，該行業超過 80 公司，雇用了約 2000 個高科技專業人才，研發支出超過 4 億加元。

在燃料電池研究和開發的分工協作方面，加拿大歷來推動不遺餘力，聯邦及卑詩省政府結合產、學、研體系基本上形成了--個產、學、研體系，大學做基礎研究，企業做發動機及汽車，提供標準的測試平臺，研究所則是聯繫大學與企業的橋樑。加拿大在政府支持下，卑詩省學術研究翹楚英屬哥倫比亞大學(簡稱 UBC)，建立了國家燃料電池研究中心，研發成果斐然，使該省在燃料電池技術方面居世界領先地位。溫莎大學和 Daimler Chrysler 公司合作建立汽車研究中心（價值 5 億加元），重點研發汽車替代燃料、新材料、汽車耐用性、機械工程設計、汽車安全、節能以及減少廢氣排放技術。

加拿大氫電池研發應用的代表企業是位於溫哥華的 Ballard Power System 公司，其質子交換膜燃料電池又稱為固體聚合物燃料電池（SPFC），在 50～100℃下工作，其電解質是一種固體有機膜，用鉑做催化劑。該公司將這種電池的鉑需要量減少了 30 倍，發電效率接近 80%。這種燃料電池是目前最有發展前途的燃料電池。據了解，在溫哥華，圍繞 Ballard 公司做燃料電池設備和零部件的公司就有 50 餘家（據產業專家表示，各公司研究方向重複的很少），公司以製造汽車用燃料電池聞名在氫燃料電池（Proton Exchange Membrane Fuel Cell PEMFC）技術上全球領先，現在它的應用領域從交通工具到固定電站，該公司被認為在開發、生產和市場化零排放質子交換膜燃料電池上處於世界領先地位。

Ballard Power System 公司最初產品是 250KW 燃料電池電站，其基本構件是巴拉德燃料電池，利用氫氣（由甲醇、天然氣或石油得到）、氧氣（由空氣得到）不燃燒地發電，燃料電池已經用於固定發電廠。Ballard 公司與世界許多著名公司合作以使巴拉德燃料電池商業化，另 Ballard 公司配合加國政府「氫能早期採用者計畫」在溫哥華和惠斯勒之間興建世界第一條氫能公路。（註：加國政府挹注 2.15 億加元資金用於開發創新氫能高速公路的建設）通過使用建在公路上 7 個氫燃料補給站，來促進車用氫燃料電池更廣泛的應用。除了氫能公路之外，尚有多項氫能公共運輸專案系列推動，包括「 氫能走廊」，即在溫莎與蒙特婁之間的 900 公里高速路設置加氫站；「氫能機場」，即以氫能技術裝備機場，使蒙特婁機場內部各式交通車輛氫能化；「氫公路專案」即在 2010 年冬奧會期間由氫燃料電池車承擔機場與主辦城市之間的人員運輸任務。

（四）風力發電

根據產業專家表示，全球風能發電力前 3 位的是：美國，年發電量 2.5 萬兆瓦；德國，年發電量 2.39 萬兆瓦；西班牙，年發電量 1.67 萬兆瓦。加拿大目前的風能發電力在世界上排名第 12 位，目前約有 210 個公司及 1,200 名專業人員，年風能發電量僅僅佔整個加拿大年發電量的 1%，提供 86 萬個家庭的年用電量。該行業生產和技術中心目集中在加拿大中部和大西洋沿岸，例如亞伯達省，薩斯卡奇萬省，曼尼托巴省，安大略省，新斯科夏省、魁北克省以及王子愛德華島等。安大略省風電機組裝機容量居加拿大之冠（413 兆瓦），其次是亞博達（384 兆瓦），再其次是薩斯克徹溫（171 兆瓦）。目前全加最大的風力電站建在魁北克省的聖勞倫斯（St lawerence River）河畔，該電站有 133 座巨型風車，年發電可供 1 萬多戶家庭使用。據加拿大風能協會（Canadian Wind Energy Association － CanWEA）對加拿大風能產業調查報告顯示，風力發電是加拿大發展最快的可再生能源。據產業專家表示，自 1998 年迄目前該產業部門每年平均 60%的成長速率穩步擴張。據統計，加國風力發電能量在

1998 年時約僅有 26 兆瓦(Maga Watts,簡稱 MW)，2008 年時即快速增加到 1876 兆瓦，預計到 2012 年加拿大將有近 10,000 兆瓦發電的的能力。

加拿大風力發電產業價值鏈結構包括零售商、分銷商、風力渦輪生產廠以及大型能源企業支援的開發商、工業企業、及具備金融資源及商業信用的基金組織。加拿大風力發電產業的企業約三分之一為生產製造類型，開發風電項目，三分之一的企業為投資諮詢公司，為生產製造企業提供專案諮詢和考察，剩下的三分之一從事風能產業的其他部分，如設備生產，專案建設以及市場開發。在產業供應鏈中，加拿大企業具有一些風機製造的技術經驗，包括塔架和底座製造、轉輪葉片製造、機艙組裝、電力變頻器、一般加工和和金屬預製件，主要產業供應基地位於蒙特婁和大多倫多地區。加拿大風力發電產業的高速發展促使越來越多的製造企業進入了這個市場，產業專家預估 2012 年加拿大預計投資 18 億加元於該產業，預期生產每 MW 容量可增加 10.5 人的就業，到 2013 年，加拿大風力發電領域將提供 13,000 個工作機會，包括生產、安裝、維修等，年營業額預計將超過 4 億加元。

產業專家表示，加拿大風力發電產業專精類別，包括製造和建造風力電塔，轉子葉片，基礎框架和逆變器。然而，由於建廠資金需求龐大，目前加國風力發電市場均為歐系及美系大廠所掌握，加國本土性之獨立供應商為數尚少。據了解，加拿大市場上的主要風力發電機供應商有 Nordex、Enercon、法國的 Jeumont、Lagerwey 和比利時的 Turbowind。2006 年到 2012 年間，GE 風力電廠陸續向魁北克省的 8 個專案提供總容量約 990MW 的風機，同時宣佈在加拿大建廠，並且本地供貨、製造和組裝的風機部件、原材料以及服務的比例將高達 60%。

另，在加國風力發電科技研發部分，根據加拿大的「風力發電計畫」，自 2006 年起，15 年內投入 9.2 億加元用於風能的開發。加拿大風力發電學院是一個獨立的非營利機構，為發展安全、可靠、高效、可持續以及低成本的風力發電提供支援，並為加拿大和全球市場提供風力發電產品和服務。加拿大風能研究所（the Wind Energy Institute of Canada (WEICan)） 於 2006 年在加拿大艾德華王子島省建成，它與大學、研究機構、私營部門和政府機構密切合作，共同對風能技術進行商業性開發。研究所重點開展四個方面的工作：測試和認證、研發、技術培訓和公共教育、以及技術諮詢和服務。主要研發：分佈產生（distributed generation)，小風輪機(small wind turbines)，為遙控彎屈柴油機系統應用風氫應用的風柴油系統(wind-diesel systems for remote and off-grid applications and wind-hydrogen applications.)。然而所有上述加拿大公司都是剛剛涉足風電行業，因此缺乏技術經驗。加拿大市場准入門檻很高，給風電產業帶來了障礙。

（五）太陽能發電

加拿大位於北半球美洲大陸上方，因為高緯度關係所以天空相較於全球其他國家更見晴朗，有很高的太陽能可行性。加國一些省政府對於綠色能源的長期承諾促進了加拿大太陽能領域的快速發展。加拿大太陽能發電的製造領域在過去的五年中發展迅速，為該國及全球市場提供服務。太陽能發電技術在過去的十年中增速超過了每年 20%。截止 2007 年為止，預計有 544,000 平方米的太陽能集熱器在加拿大運轉——主要是由無釉塑膠質地的太陽能集熱器進行泳池加熱（占 71%），以及用無釉多孔太陽能空氣集熱器用來進行商用建築的採暖（26%），釋放大約 627,000 吉焦耳（GJ）的能量，進而取代每年 38,000 噸二氧化碳的釋放量。 產業專家預估，大約有 150 家太陽能發電企業（銷售公司、批發公司、產品製造商、私營諮詢公司、設備安裝公司以及行業協會等）帶動加拿大的太陽能發電市場。

在加拿大，光能（Photovoltaic, PV）的技術已成為可再生能源技術。據產業專家表示，現在用於生產太陽板的基本材料有兩種：矽和塑膠或聚合物。矽應用較佳，但缺點是太硬、脆弱、昂貴。塑膠較廉價，但效果相差甚遠。加拿大太陽能熱水裝置產業有供應商、分銷商以及太陽能集熱裝置和熱交換設備的製造商、水泵生產、蓄水設備以及行業規定制定者。加拿大太陽能氣體加熱設備技術已應用於全球範圍內，用於農作物的烘乾。加拿大的先進技術使眾多南美及亞洲國家的農業生產者可以轉向應用更加環保及可持續發展的烘乾手段。加國有能力生產一種可將太陽能轉換成電能的軟性塑膠。運用這種新型塑膠生產的薄膠片太陽板要比採用目前類似材料價格低三倍。這種新材料不僅能夠吸收可見光，而且還可吸收太陽紅外線——熱量，從而提高了太陽能電池功效。據悉這種創新發明的新聚合物電池，電池可用於彎曲表面，如用於手機，或者服裝裏面，甚至可放在汽車頂棚上面給電瓶充電。

（六） 海洋能源發電

加拿大被三大海洋所包圍，造就了其豐富的潮汐洋流及海洋能量資源。據專家表示，海洋能源的擷取有多種途徑，分別是海浪，潮汐，海洋熱潮，及鹽梯度等。雖然大部分的海洋能技術目前還未在商業上應用，但幾個示範性專案已經使此領域為社會帶來相當具有影響力的環保利益。

海洋專家表示，海洋能源尚屬新興行業，在研發面臨許多技術挑戰，海洋能源開發科技，許多目前仍處於原型及觀念發展階段。以波浪和潮流發電為例，海浪能源來自於海洋表面因風而起的波浪。海浪能源擷取設備係利用海浪平行或垂直運動而設計。就加拿大的海洋環境而言，海浪及潮汐是擷取海洋能源最有效的方式。加拿大能源委員會（National Energy Board）預估，加拿大海浪及潮汐發電量可達 20,000 百萬瓦，這還不包括河流可以產生的能源。潮汐能源來自於可預測的太陽及月亮引力對潮汐升降的影響。潮汐能源研發工作，大部份專注於潮汐水流科技，利用設於海底的潮汐渦輪機，藉水的運動產生能源。海底潮汐渦輪機，擷取潮汐能源的經驗，

可以應用於河流，擷取另一種再生能源。然而大型潮流發電站，會使幾百公里內的沿海潮差受影響。此外還有泥沙淤積問題以及對沿海各國動植物、魚類和鳥類棲息地等特殊生態環境的影響問題。在沿海築壩建大型潮汐電站所導致的環境與生態問題可能比在河川築壩還要嚴重。因此加國政府正審慎考亮此一類型能源發展之前景。

加拿大聯邦政府自然資源部轄下的研究機構 CanmetENERGY 研究人員及科學家，協助各省從事海洋能源的研發計畫。海洋能源研發計畫專注於解決此一新興工業面臨的各種技術性問題。加拿大的海洋能源研發團隊亦參加了國際能源署海洋能源系統實施協定（International Energy Agency Implementing Agreement on Ocean Energy Systems，簡稱 IEAOES）。這個協定經由國際合作及資訊交換，協調並協助海洋能源的研究，發展及示範。

三、 加國綠能產業重鎮-卑詩省產業發展概況

產業專家指出，加拿大為全球綠色產業發展重鎮，加國政府、企業與民間皆積極推動節能減排政策及措施，並亟思落實環境保護意識，其中卑詩省部分在加國綠色能源產業發展過程中，扮演著舉足輕重的地位，卑省的先進能源產業除了整體產業發展領先加國其他省份外，多項技術並執國際市場牛耳。以產品角度觀之，在電動機、發動機、燃料電池和可選擇燃料等領域擁有眾多世界知名的企業。根據卑詩省府提供的資料顯示，該地區是世界上領先的先進能源開發中心之一，包含超過 250 間公司，或從事技術開發和利用，或提供專門設計的服務，此外，卑詩省的大學、學院和研究機構還在進行能源技術和系統的領先研究，並在開發複雜的模式，以協助經濟規劃和政策制定。

加拿大綠能產業重鎮即為太平洋沿岸之卑詩省，卑詩省是世界上第三大清潔能源技術群體，依官方資料顯示，該省在潔淨能源市場部份約有大約 18,000 名從業人員，僅在技術開發領域就有大約 3700 人就業，而且還有更多的人在相關的能源服務和輔助行業，研發活動的規模也最多樣。以加拿大在永續經營綠色能源多面向的研發投產力度及決心，未來勢將在全球綠能產業發展歷程扮演舉足輕重的角色。據 Globe Foundation of Canada 研究資料顯示，到 2020 年，國際市場有關環保產品及服務預計將倍數級距擴大，而卑詩省該產業整體經濟規模屆時可達到 270 億加元。該報告定義綠色產業部門計包括：「清潔與替代性能源」(Clean and alternative energy)、「能源效能與管理」(Energy management and efficiency)、綠能建築(Green building)、環境保護(Environment protection)、碳交易(Carbon finance and investment)和綠智能(Green knowledge)。據估計，上述六大該部門 2008 年總產值高達 183 億加元及提供 166000 個工作機會，約佔卑詩省整體就業市場 7.2%，倘以經濟貢獻角度分析，綠色能源產業 6 個部門對卑詩省整體 GDP 挹注 153 億加元活水。約佔該省 GDP 產值之 10.2%，其中以「清潔與替代性能源」(Clean and alternative energy)及「能源效能與管理」(Energy

management and efficiency)兩部門表現最為亮麗，合計挹助於卑詩省能源產業(約佔該省綠能 GDP 產值之 55%)約 6 億加元。該研究報告市場預估，至 2020 年時卑詩省綠能產業總產值將可增達 210 億至 273 億加元之規模，換算於年增率則介於 2.7%至 5%之間。而綠能產業項次部門中，則以綠能產業中「能源效能與管理」及「綠建築」(Green Building) 為最具發展潛力的項目。但是，專家亦提供卑詩綠能產業發展仍潛藏未可預知的負面因素，例如，綠產業人力供應及為一項重要可能延至產業迅速發展之因素，據預估，屆 2020 年時卑詩省綠產業直接與間接產業人力需求將達 22 萬 5,000 人之譜

根據可持續性能源(Sustainability Energy)產業調查，卑詩省大部分先進能源產業都是出口導向性的，約 95%的產品銷售到卑詩省以外的地方。以氫氣及燃料電池部份觀察，卑詩省在燃料電池研發方面的支出佔全加拿大的 75%，雇員人數佔全加拿大的 69%，是世界上最大的氫氣和燃料電池產業基地。此外，卑詩省的“Hydrogen Highway”大型氫氣推廣計劃正在如火如荼地進行，目的是促使氫氣和燃料電池科技更快地投入商業市場。冬季奧運會和殘奧會會場也依照美國綠建築委會所提出的評估系統「領先能源與環境設計（LEED）」中，最新的綠建築標準，進行冬奧新建場館和比賽場地的設計與規劃，計畫中的建築坐落位置，避免對溪流、森林、野生動物棲息地和自然生態系統破壞；在溫哥華和惠斯勒新建的兩座選手村，則有採用太陽能板建材設計的模範建築。卑詩省政府在 2010 冬季奧運結束後，正積極與建商修建選手村內居住設施，希望以該社區之規劃，建立永續居住的綠色環保模範社區。

四、 加國政府政策轉變

加拿大再生能源事業之所以可以取得今天的成績，主要得益於有效的政府鼓勵政策。然而在經歷了全球經濟衰退的同時，加拿大政府也進行財政方向的調整，取消對可再生能源發展進行補貼的生態計畫。

產業專家認為，如果沒有政府政策的支持，加拿大的可再生能源發展勢將受限，進而實質影響可替代性能源發展，更將降低加拿大綠色產業的世界競爭力，並延滯加拿大在吸引投資、創造就業等各方面努力。

據了解，加拿大自 2007 起推動生態能源計劃。該計畫實施以來，已經為加拿大超過 4000 兆瓦的可再生能源項提供了資金支援，其中就包括許多再生能源專案。為肇因於全球經濟緊縮，加拿大政府預定自 2011 年 3 月開始，停止政策性補貼所有能源專案。而 2012 年後可再生能源項目也將不會得到政府的投資。產業專家表示，政府方針將肇致業者投注於產業發展之增幅躑躅不前，從而影響到投資者的信心，甚至可能導致國際綠能資金流向其他國家。影響所及，加國綠色能源未來的發展是否一如往常獨佔全球先鋒，尚待觀察

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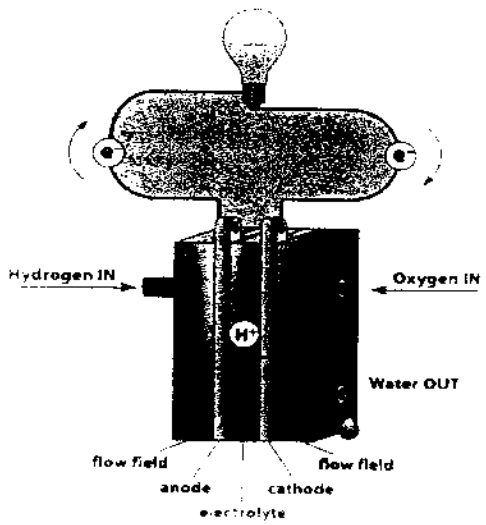
A fuel cell is an electro-chemical energy conversion device that uses hydrogen or other fuels to produce electricity, water, and heat. It operates much like a battery but doesn't consume electrode material or require electrical recharging. In fact, a fuel cell can generate power almost indefinitely, as long as fuel is supplied. They can also be scaled to power everything from cell phones to automobiles to entire buildings.

A fuel cell stack

Fuel cells run on hydrogen, the most abundant element, which makes up over 80 per cent of our universe. It is highly reactive and is almost never found in a naturally free state, but rather bonded to other elements. In fact, hydrogen combines easily with oxygen to create water.



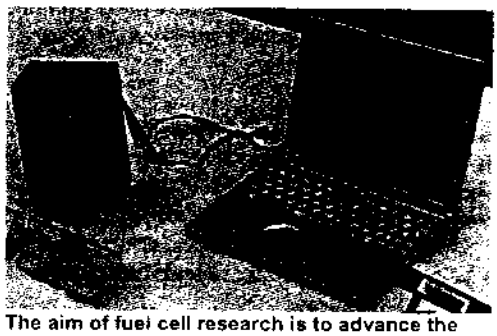
Individual fuel cells typically generate less than one volt. In order to get a practical voltage, cells are therefore combined into a fuel cell stack, and the number of cells in the stack determines its output voltage.

National Research Council Canada
Conseil national de recherches Canada
Canada

Our world with fuel cells

Hydrogen fuel cells have the potential to solve the world's environmental challenges because they are easy to use, silent, efficient, clean and sustainable, and available everywhere.

Imagine never having to replace the battery in your laptop or cell phone. Batteries are expensive, and, eventually, must be replaced or recharged. Fuel cells, however, continue to generate electrical power as long as fuel is supplied, which means more power and less battery waste in landfills. Fuel cells successfully provide backup power for rural or remote communities not connected to the energy grid, and provide limited power for essential services during a power outage.



The aim of fuel cell research is to advance the technology and commercialize it for use in a variety of applications, including use in portable devices such as laptops and cell phones

Our facility

Located on UBC's south campus, our facility is one of the greenest buildings in Canada. Built in 2006, it earned a gold-level Leadership in Energy and Environmental Design (LEED) "green building" certification. LEED is a national standard for developing sustainable buildings.

Our state-of-the-art facility is designed to showcase environmental and sustainable technologies, including rooftop photovoltaic cells coupled to an electrolyzer that uses solar energy to generate hydrogen for use in lab experiments or an emergency back power system, a 5 kW solid oxide fuel cell power generator, and a ground-source heating and cooling system.

The facility has nine world-class fuel-safe laboratories, several fuel cell test stations, and a Hydrogen-safe Environment Chamber (HEC) that allows researchers to test products in various climates by controlling humidity, temperature and altitude.

Demonstration projects

NRC-IFCI is a major participant in the Vancouver Fuel Cell Vehicle program, which was established to test and evaluate five Ford Focus cars over a three year period. It is home to the Pacific Spirit Fuelling station, which provides fuel for the vehicles, and its maintenance bay is where valuable vehicle performance data is collected. The Pacific Spirit Fuelling Station is also a key node on Vancouver's Hydrogen Highway.

The Pacific Spirit Fuelling Station

The Hydrogen Highway

The Hydrogen Highway is an advanced hydrogen and fuel cell technology demonstration program for showcasing BC's growing network of hydrogen fuelling stations that provide fuel and support for various stationary, portable and mobile fuel cell applications. Since 2004, several fuelling stations have been established in communities across BC's lower mainland to accelerate production and commercialization of hydrogen and fuel cell energy systems.

Further reading

NRC-IFCI home page:
www.ifci-iipc.nrc-cnrc.gc.ca

Vancouver Fuel Cell Vehicle Program:
www.vfcvp.gc.ca/index_e.html

Canadian Hydrogen & Fuel Cell Association:
www.chfca.ca

BC's Hydrogen Highway:
www.hydrogenhighway.ca

Contact

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Sylvia LeRoy
NRC-IFCI Communications Officer
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February 2009
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NRC·CNRC
Institute for
Fuel Cell Innovation

Science
at work for
Canada

Technology Evaluation Program (TEP)

The Program

The National Research Council Institute for Fuel Cell Innovation (NRC-IFCI) Technology Evaluation Program (TEP) advances Canada's leadership in fuel cell and hydrogen technologies to provide clean, sustainable energy options for society's benefit. Backed by a highly qualified, multi-disciplinary team of engineers, scientists and technologists, the TEP works with industry, government and academic partners on a wide range of projects.

The experience and flexibility of the TEP team lets clients test, validate and improve the performance, efficiency, safety and reliability of their clean energy technologies on-site. Organized across three key streams— services, applied research & engineering, and demonstration— the TEP adapts to address and accommodate varied client needs.

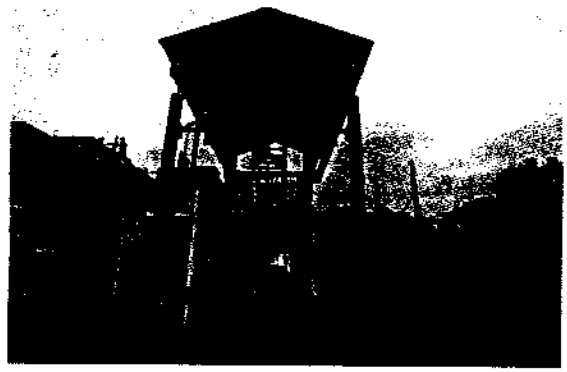
Services

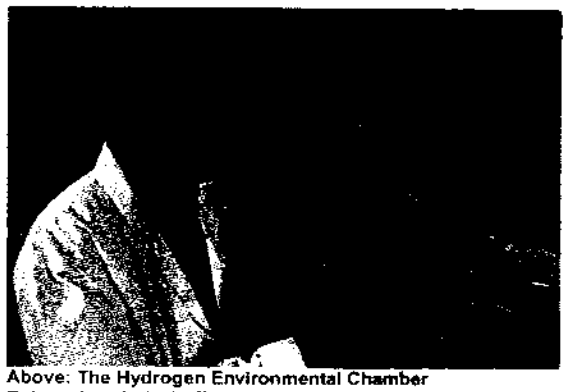
Complementing the NRC-IFCI's fundamental and applied research, the TEP runs the Advanced Testing and Validation Centre (ATVC). An innovative, state of the art facility, the ATVC provides companies with objective, reliable and accurate testing and validation of hydrogen, fuel cell and other clean energy technologies for the global market.

A unique facility, the ATVC offers companies year round access to a range of environmental and electrochemical fee-for-service test equipment supported by highly skilled professionals on-site.

Hydrogen Environmental Chamber

The Hydrogen Environmental Chamber (HEC) enables partners and researchers to test and evaluate fuel cell and other clean energy systems in a variety of extreme environmental conditions. Testing in the HEC is an efficient way to minimize cost and reduce field trial requirements.





Above: The Hydrogen Environmental Chamber
Below: A technical officer conducting an electrochemical test

The HEC is also equipped with a vibration table and dynamometer. The vibration table can be used to test a variety of equipment and components to within military standards. A dynamometer additionally allows for the simultaneous testing of a vehicle's drive train response to various environmental conditions.

Electrochemical Test Centre

A suite of fuel cell, battery and supercapacitor test stations (500W to 5KW) are available to clients. They can be configured to automatically control and log test conditions and provide valuable data to clients.

Mechanical Design and Fabrication

The TEP provides clients with complete engineering and precision prototyping services. Advancing research discoveries and their transition from the lab to the end-user, the TEP specializes in single part and low quantity runs of SOFC & PEM Fuel Cell stacks, test fixtures, balance of plant components and systems design. NRC brings best-of-class processes and techniques to bear on both R&D and commercialization projects.

Applied Research and Engineering

Applied research and engineering undertaken by the TEP team emphasizes the system and application-level research in several areas of clean energy engineering, including transportation, energy storage and other applications. With expertise in mechanical engineering, physics, electrochemistry, instrumentation and electronics, safety and mathematical modelling, the TEP provides science and engineering research, technical support services, specialty products, and integrated high performance solutions for today's clean energy technologies.

Demonstrations

Committed to innovation, the TEP team provides opportunities for clients to showcase Canadian technologies and companies through demonstration projects. Projects include the demonstration of fuel cell and clean energy technologies in real, everyday conditions; the testing of alternative fuels to projects exploring the viability of new fuel infrastructure technology; exploring the path to commercialization; and, increasing public awareness of emerging technologies.

Hydrogen Highway

NRC-IFCI has supported the Hydrogen Highway™ since 2002, when it first launched the demonstration project concept with BC Hydro, Methanex Corporation, and the Canadian Hydrogen and Fuel Cell Association (CHFCA). The TEP has maintained and operated the Pacific Spirit Fueling Station, one of the key nodes along BC's Hydrogen Highway. The team has also provided technical support for the Vancouver Fuel Cell Vehicle Program (VFCVP) and other stationary deployments, which are showcased on-site in the Hydrogen and Fuel Cell Gateway technology demonstration and exhibit centre.

Vancouver Fuel Cell Vehicle Program

NRC-IFCI provided a home for the CHFC
managed Vancouver Fuel Cell Vehicle Progra
(VFCVP) until the program's completion in 201
The professional expertise of the TEP Tea
enabled members of the VFCVP to put fuel ce
vehicles to work in real-world applications in orde
to evaluate system performance and reliabilit

Since 2005, th
fleet of five For
Focus vehicle
accumulated mor
than 300,000 rea
world kilometres
The VFCVP was
demonstration c
what is possible
illustrating a mor
sustainable metho
of transportation. It'
about puttin
hydrogen energy
into motion.

Competencies

The TEP has skills and experience in a wide range of fields. Core competencies include:

- ✓ *Application Modelling & Development*
- ✓ *Fuel Cell System Integration in Buildings*
- ✓ *Aerospace*
- ✓ *Balance of Plant*
- ✓ *Stationary*
- ✓ *System Design for Flex Fuel SOFC*
- ✓ *Integrated PEM Catalyst Development*
- ✓ *Codes & Standards Development*
- ✓ *Hydrogen, Carbon Monoxide & Nanoparticle Safety*

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Institute for Fuel Cell Innovation

Science at work for Canada

Active Flow Field Control in PEMFC

The Technology

Active flow field control is a new proprietary (patent pending) fuel cell design developed by the National Research Council's Institute for Fuel Cell Innovation (NRC-IFCI) in collaboration with the University of British Columbia.

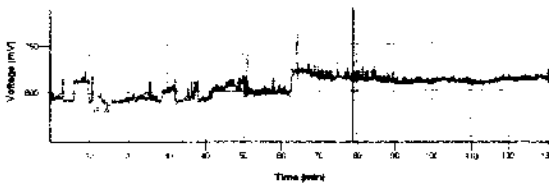
This unique design alters the active area of proton exchange membrane fuel cells (PEMFC) as operating conditions change. Active flow field control can reduce low current density failure modes, improve the cell-to-cell reactant distribution and improve fuel cell performance stability without increasing the parasitic power consumption or cost.

Advantages

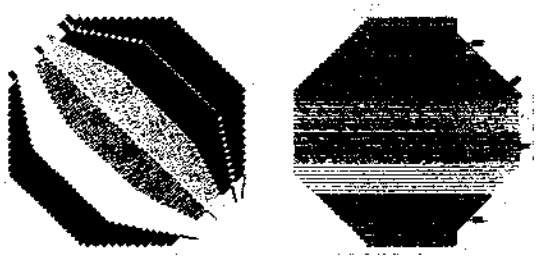
The flow fields in current PEM fuel cells have fixed flow channel geometries and fixed active areas. They are optimally designed around their maximum power operating point with the goals of maximizing performance and minimizing pressure drop between inlet and outlet of the flow field.

However, because this design is optimized for peak power, it performs poorly under low power conditions. At lower power, pressure drop is reduced, affecting water management and reactant distribution, causing reliability issues to occur over the active area. Problems with cell-to-cell reactant distribution in the fuel cell stack and cell voltage reversal due to liquid water clogging in the channels and gas starvation can also occur.

The NRC-IFCI approach can resolve the issu facing PEMFCs that have fixed flow chann geometries and active areas at lower pow operation. Active flow field control in the flo field plate is easy to carry out and can be use in PEMFC with variable load such a automotive or stationary applications.



Voltage traces before (left of line) and after (right of line) reducing active area of a single cell by closing four valves of an interdigitated fl field operated under a low load/power condition of 80 mA/cm², λair = and λhydrogen = 1.5



Active flow field designs with serpentine flow channels (left) a interdigitated flow channels (right)

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Canada

Market & Business Opportunities

This device is suitable for a wide range of high value-added power generation applications (from milliwatts to kilowatts) where PEMFC is employed as an independent power source with variable load, including portable electronic devices, automotive and light duty mobile devices.

Stage of Development

The technology has been demonstrated in the lab at the single cell and stack levels. Demonstration PEMFC Single Cells and stacks are available for testing.

Technical Specifications

Total single cell active area	[illegible] (interdigitated) [illegible] (serpentine)
Number of active sections per cell	6
Interdigitated sectional active areas	[illegible] 52.2cm², [illegible] 49.4cm², [illegible] 49.4cm²
Serpentine sectional active areas	46.6cm², 47.2 cm², 46.2cm², 46.2cm², 47.2cm², 46.6cm²

The active area of the cathode flow field for this technology is divided into several separate sections. Each section is connected to an external valve at the exhaust of the flow field that can be controlled separately. If a valve is closed, the corresponding area in the flow field is also closed. This forces the reactant into the other active sections, increasing the effective reactant flow and associated pressure drop.

The active flow field control concept was proven for interdigitated and serpentine flow field plates at low power (50-200 mA/cm^2) with a constant H_2 stoichiometry of 1.5. The air stoichiometry was varied to a lower stoichiometry of 1.1-1.5.

IP Status

Patent pending: WO 2005121917,
US 2008248365, CA 2569859

Licensing available

Contacts

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Remote Power, Bella Coola

BC Transit 20 Fuel Cell Bus Deployment, Whistler

Whistler Fueling Station, Whistler

Ford Focus Fuel Cell Vehicle Deployment, Powertech Labs, Surrey

Ford Focus Fuel Cell Vehicle Deployment, BC Transit, Langford

BC Transit Victoria Fueling Station, Langford

GM Equinox Fuel Cell Vehicle Deployment, Various Locations

Fuel Cell Electric Bus exhibit at the BC Pavilion for the 2010 Winter Games, Vancouver

Ford Focus Fuel Cell Vehicle Deployment, National Research Council Institute for Fuel Cell Innovation, Vancouver

Pacific Spirit Fueling Station at the NRC, Vancouver

H_2 Shuttle Bus and Pick-up Truck Deployment, North Vancouver

Northlands Fueling Station, North Vancouver

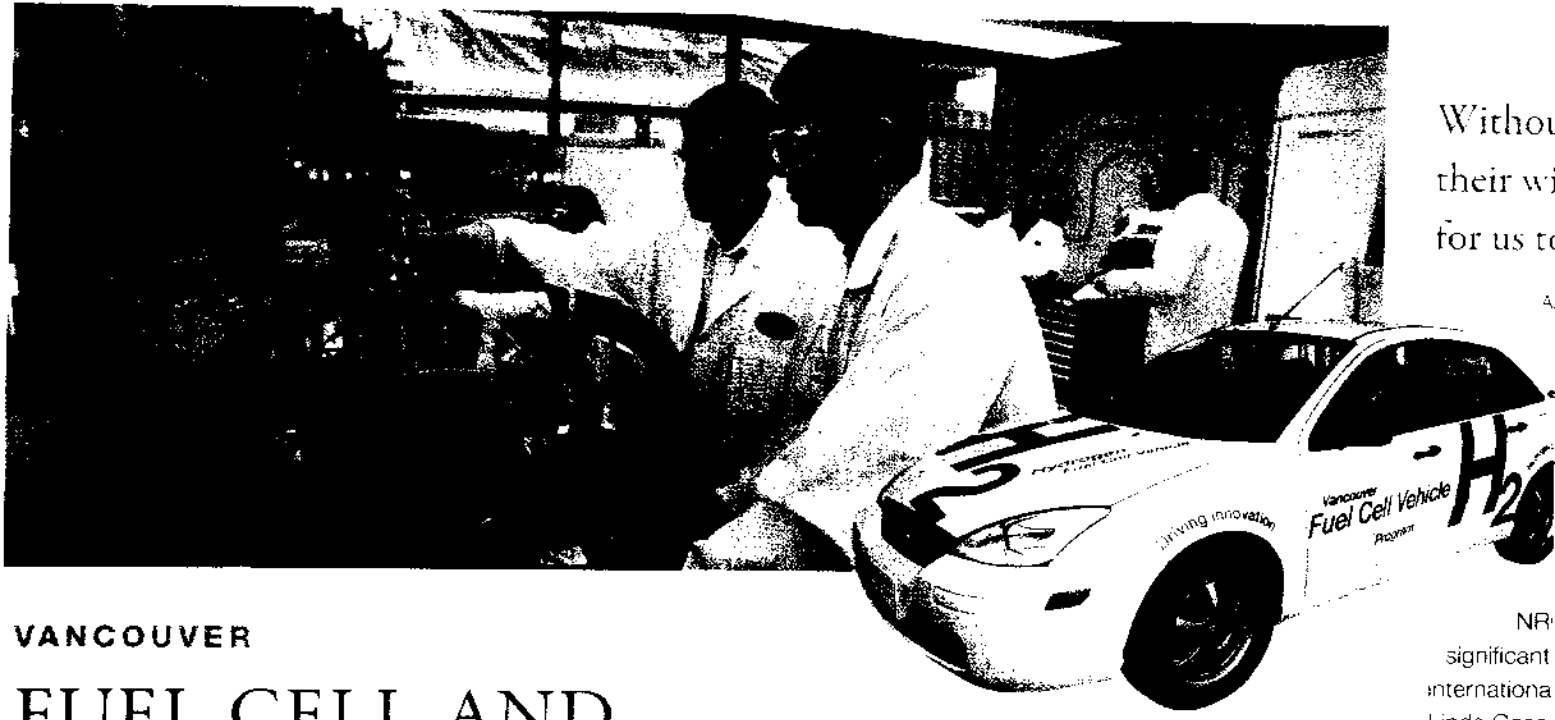
Stationary Fuel Cell at Easy Wash Car Wash, North Vancouver

Hydrogen Waste Capture, North Vancouver

Mercedes F-CELL Vehicle Deployment, Various Locations

Ford Focus Fuel Cell Vehicle Deployment, Automotive Fuel Cell Cooperation Corp., Burnaby

Fueling Station and Airport Baggage Tugs at the Vancouver International Airport, Richmond



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FUEL CELL AND HYDROGEN TECHNOLOGIES

STRATEGICALLY POSITIONED FOR GROWTH

While pockets of fuel cell research exist in other locations across Canada, Vancouver remains the national hub for groundbreaking R&D, accounting for nearly 70 percent of the roughly 2,000 Canadian jobs in the field. NRC's focus is to build on the success to date by securing Canada's competitive edge in H_2/FC commercialization. To reach this goal, NRC supported Canada's Fuel Cell Commercialization Roadmap, a federal government initiative to identify opportunities in fuel cell R&D and map a strategy for technology commercialization.

NRC is partnering with others to bring pioneering technologies to market through 28 industrial collaborations, 20 university partnerships and 13 international projects. NRC has also strengthened its relationships with three local universities to help develop and attract talent for H_2/FC employers, establish hydrogen and fuel cell consortia, and build a knowledge advantage for the region and for Canada. In partnership with industry, NRC earned the support of the provincial government for a BC Hydrogen and Fuel Cell Strategy.

A CATALYST FOR INNOVATION

The NRC Institute for Fuel Cell Innovation (NRC-IFCI) supports the H_2/FC industry by helping it solve technological, regulatory, and innovation barriers. It delivers value through:

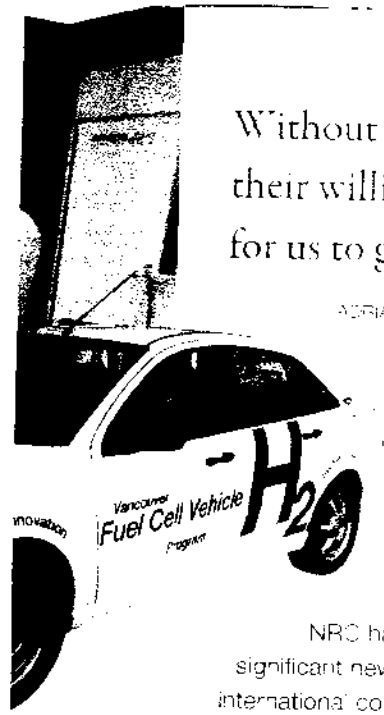
- the Low Temperature fuel cell Program, focused on increasing the reliability, durability, performance and flexibility of PEMFCs (Proton Exchange Membrane Fuel Cells) while decreasing costs;
- the High Temperature fuel cell Program, focused on improving durability and lowering system costs associated with SOFCs (Solid Oxide Fuel Cells) by reducing operating temperatures and increasing system flexibility; and
- the Hydrogen Technologies Program, focused on advancing the use of hydrogen as an energy carrier.

These and other NRC initiatives enable world-class staff, visiting workers and graduate students to develop competencies and knowledge for use in collaboration with industry to address short and long-term technical needs. NRC-IFCI also serves as an incubator for 11 start-up H_2/FC companies.

DEMONSTRATING FUEL CELL POTENTIAL

NRC-IFCI operates a cutting-edge, public testing facility that is unique in North America. The Advanced Testing and Validation Centre (ATVC) enables small and medium-sized enterprises (SMEs) to test fuel cell ideas and prepare innovations for international markets. NRC also collaborates with cluster partners to showcase real world applications of groundbreaking hydrogen and fuel cell technologies. Demonstration projects include:

- a state-of-the-art LEED ® Gold certified green research facility, with integrated clean energy technologies including fuel cells;
- the Gateway, a technology demonstration and exhibit centre showcasing hydrogen and fuel cell technologies that are in the marketplace today;
- the Vancouver Fuel Cell Vehicle Program, which addresses barriers to commercialization and public acceptance; and



> Without NRC – the investment they were willing to make in infrastructure, and their willingness to incubate new companies – it would have been very difficult for us to get off to such a quick start and attract customers as quickly as we did.
>
> ADRIAN DOBLESS, CHIEF TECHNICAL OFFICER, PLUG POWER CANADA

- British Columbia's Hydrogen Highway™, for which NRC provides hydrogen refuelling infrastructure as well as transportation, micro and stationary fuel cell demonstrations.

NRC has helped the Vancouver cluster attract significant new investment to British Columbia, with international companies such as Ford Motor Co. and Linde Gases locating on-site to develop critical demonstration projects.

TRANSFORMING TECHNOLOGY INTO BUSINESS

NRC offers other strategic services that help businesses to develop and commercialize their science and technology innovations for marketplace success and growth.

ASSISTING WITH INDUSTRIAL RESEARCH

The NRC Industrial Research Assistance Program (NRC-IRAP) helps SMEs across Canada. It provides technological and business advice and expertise, along with potential financial support to R&D-oriented companies, including those operating in NRC's cluster initiatives.

Through its extensive network of industrial technology advisors, the program links companies in the cluster to appropriate sources of technical and business expertise, market information and local financing. It also facilitates international connections via technology missions. NRC-IRAP has developed close relationships with the majority of fuel cell firms in British Columbia, supporting innovative research and development, and the commercialization

MILESTONES in Cluster Progress

2003 NRC-IFCI establishes collaborations with BC universities to support cluster growth through increased supply of skilled personnel.

2003 NRC and Western Economic Diversification announce $1.5 million for Hydrogen Environmental Chamber, unique in North America.

2003 NRC supports launch of Industry Canada's first Canadian Fuel Cell Commercialization Roadmap subsequently updated in 2008.

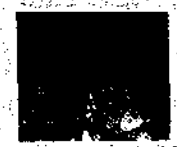
2003-2004 The Province of BC adopts the BC Hydrogen and Fuel Cell Strategy and with the Government of Canada unveils the Hydrogen Highway™, the world's first large-scale, integrated hydrogen fuelling demonstration project.

2007 BC Transit launches $89 million project to deploy 20 hydrogen fuel cell buses with funding from the Province of BC and the Government of Canada.

2008 Plug Power Canada sells 200 fuel cell units to Sobeys Grocers, the largest order to date of stationary fuel cells.

2008 Daimler AG and Ford locate Automotive Fuel Cell Cooperation (AFCC) Corp. in Vancouver.

2009 NRC-IFCI opens Advanced Testing and Validation Centre (ATVC).

2009  Ballard / IdaTech back-up power fuel cell systems pass factory certification tests through validation in NRC ATVC, supporting the largest sale to date of commercial PEM fuel cells for telecom towers in India.

2009 NRC-led Canada-China Alliance links BC cluster companies to Chinese suppliers with the support of the Province of BC.

of new fuel cell products and services. In 2008-2009 alone, NRC-IRAP provided almost $1 million in funding to 10 organizations in British Columbia's H_2/FC sector.

USING INFORMATION INTELLIGENCE TO TURN KNOWLEDGE INTO COMMERCIAL APPLICATIONS

As Canada's national science library, the NRC Canada Institute for Scientific and Technical Information (NRC-CISTI) provides access to global science, technology and engineering information.

NRC's information specialists and technical business analysts in Vancouver leverage their access to this information to provide critical information services that clients need to position their activities strategically, optimize R&D investments, and generate commercially successful outcomes. To do this, they offer many services:

- technology commercialization intelligence
- information research and analysis
- patent landscape analysis
- groundbreaking technical information
- cutting-edge industry and market information
- rapid delivery of up-to-date full text articles from online sources
- referrals to industry experts or organizations.

Cluster Facts at a Glance

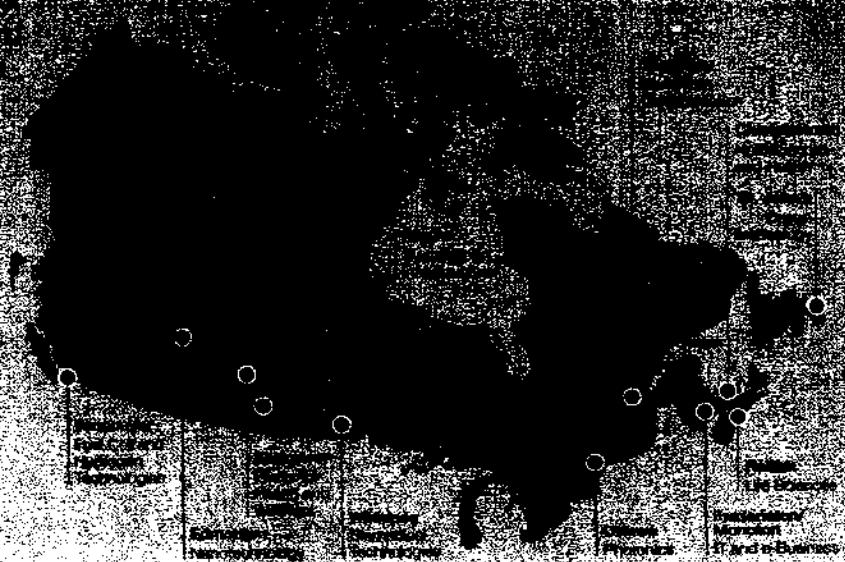
- The Canadian industry has grown from less than 20 companies in 1997 to a world leader with approximately 80 organizations investing $193 million in R&D and generating $133 million in revenues per year a decade later.
- In the 2008 bibliometric study by Science-Metrix, the BC fuel cell cluster was ranked number one for research output in the world, and most of it was attributed to NRC and the University of British Columbia (UBC).
- Vancouver area companies such as Ballard Power Systems Inc., Plug Power Canada and Hydrogenics are already leaders in international markets.
- 20 hybrid fuel cell buses will be deployed in the region for the 2010 Winter Olympic and Paralympic Games, reducing greenhouse gas emissions by 62 percent relative to diesel equivalents.
- The BC H_2/FC cluster is a leading component of a larger sustainable energy sector in British Columbia that grosses $700 million in annual revenues.

NRC'S CLUSTER PARTNERS

- Canadian Hydrogen and Fuel Cell Association (CHFCA)
- Simon Fraser University
- University of British Columbia
- University of Victoria
- Government of British Columbia
- BC Hydro
- BC Transit
- Western Economic Diversification
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Natural Resources Canada (NRCan)
- Industry Canada
- Foreign Affairs and International Trade Canada
- Automotive Fuel Cell Cooperation (AFCC) Corp.
- Ballard Power Systems
- Hydrogenics
- And many more

Global Reach — Local Touch

NRC plays a pivotal role in building a competitive advantage for Canada, based on science and technology strengths in communities across the country. The NRC commitment to fostering clusters has made it a catalyst for technological progress and economic growth in every region of Canada. NRC's successful clustering model encourages local entrepreneurial and people advantages, while leveraging the knowledge advantages of NRC — capitalizing on its national and international resources, science and technology capabilities, networks and partnerships. This proven approach supports each cluster based on its unique needs, opportunities and challenges, with NRC as the cluster's flexible and determined partner.



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NRC Institute for Scientific and Technical Information (NRC-CISTI)
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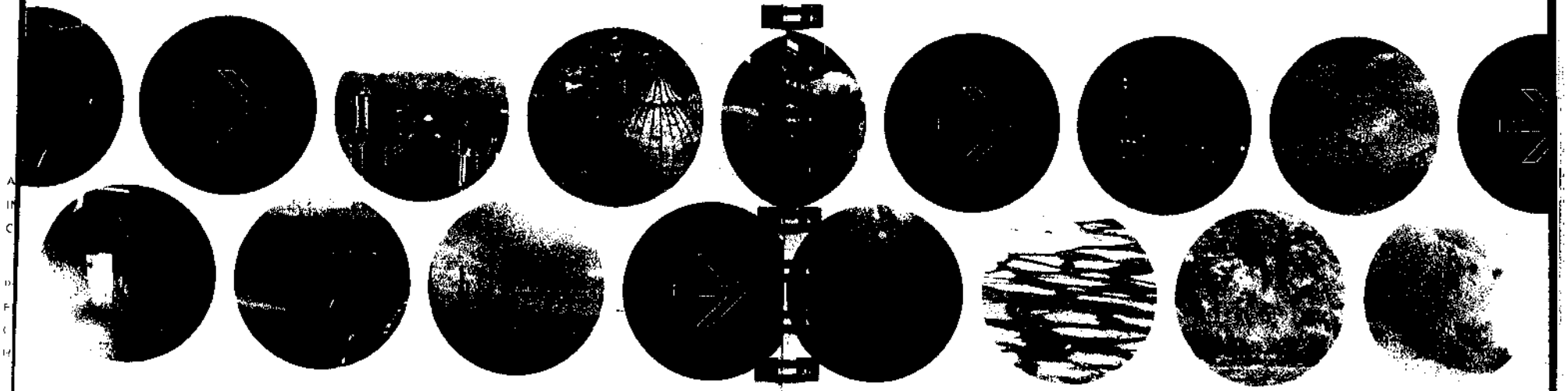
THE CANADIAN HYDROGEN AND FUEL CELL SECTOR IS REACHING A CRITICAL COMMERCIAL THRESHOLD

OVERVIEW: HYDROGEN & FUEL CELL SECTOR

Hydrogen and fuel cell products are being tested and commercially deployed in materials handling, backup power, portable electronics, residential co-generation, fueling infrastructure and transit bus applications.

The focus on these near-term markets is allowing Canadian companies to concentrate on developing and marketing products that will generate early revenue streams, cultivate investor confidence and build consumer awareness and acceptance. This early commercial traction will pave the way for the deployment of medium-to-long term applications such as hydrogen fuel cell automobiles.



Perceptions about energy are evolving – where it comes from, and how it is used:

The rapid economic growth of developing nations such as China and India, together with our own already energy-intensive lifestyles, is placing unprecedented strains on global energy supplies and power generation capacity.

There is growing awareness of the very real consequences associated with the accessibility of oil supplies. Nations across the globe continue to consider and struggle with geo-political tensions inherent to importing oil and energy.

Air pollution continues to be a concern in many urban centers of the industrialized world and in developing countries. Emissions from industry and motor vehicles release smog, ozone, particles, and nitrogen and sulfur oxides into our environment, all of which can severely affect our health.

There is also growing awareness of the implications of climate change caused by the emission of greenhouse gases, much of which is generated by burning fossil fuels (coal, oil and natural gas). Many consider climate change to be one of the biggest challenges facing humanity over the next century.

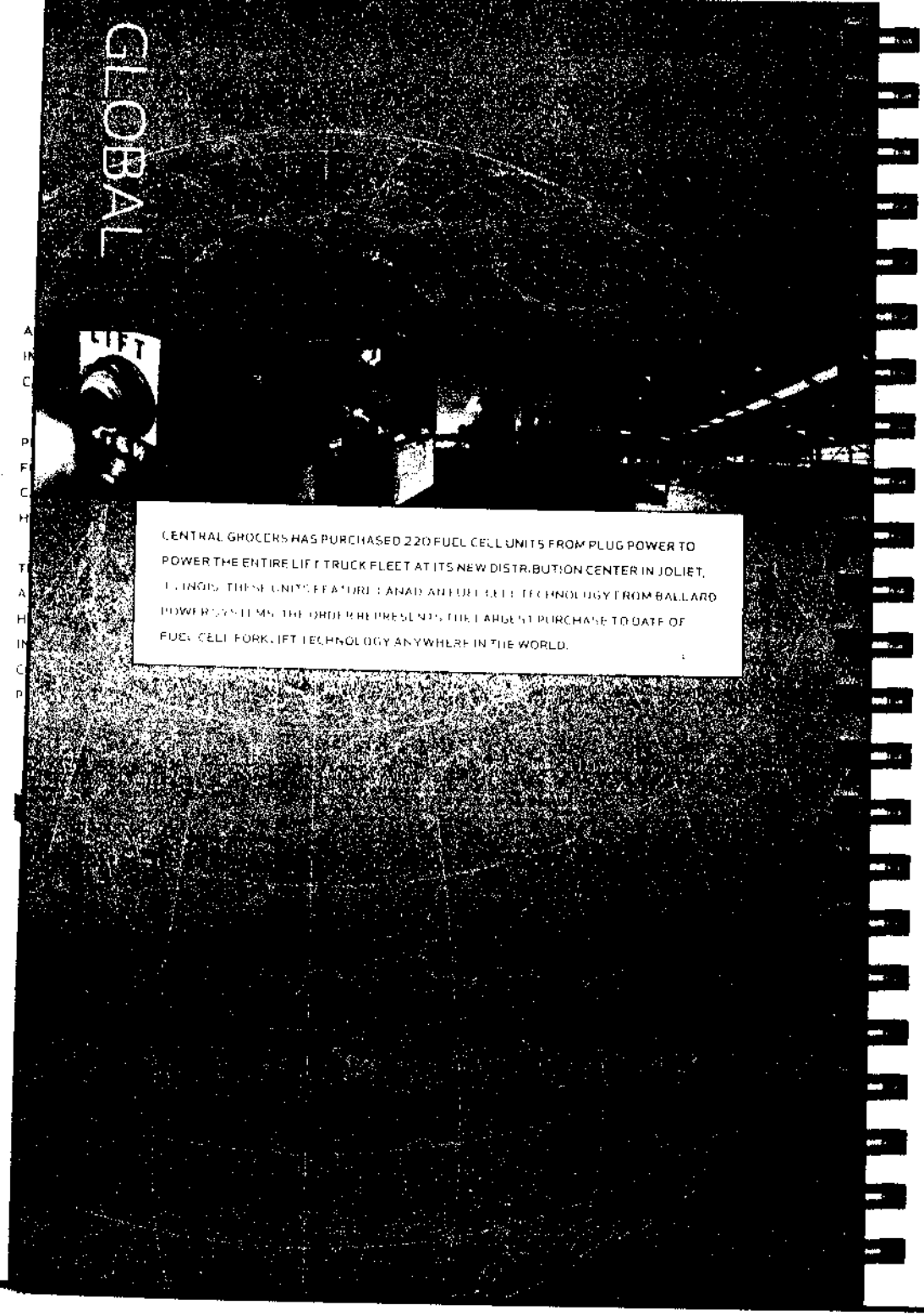
These realities are driving the development of new technologies and ideas. In Canada, the development of hydrogen and fuel cell technologies and products will improve the air we breathe, ensure secure and reliable energy, reduce the emissions that cause climate change and create highly skilled jobs.

The potential applications for hydrogen and fuel cells are countless – from running our vehicles, to powering our cellular phones and laptops, to heating our businesses and homes. The technology enables clean energy systems by reducing the carbon impact of fossil fuels and supplementing the intermittent nature of renewable energy sources.

For Canada, the chance to take advantage of its hydrogen and fuel cell capabilities is significant. With its nucleus of leading hydrogen and fuel cell companies and research institutions, Canada enjoys substantial, world-recognized expertise in this field.

As a pioneer of hydrogen and fuel cell technologies and products, the Canadian sector has enjoyed rapid growth in the last ten years. In 1997, less than 20 companies maintained hydrogen and fuel cell activities. Today, the Canadian hydrogen and fuel cell sector features over 100 stakeholders, including a growing number of core technology developers. Canadian capabilities include fuel cell technology development, hydrogen production, components, systems supply and integration, fueling and fuel storage, and engineering and financial services. Canada's hydrogen and fuel cell expertise extends across the country, in centres such as Calgary, Toronto, Kingston, Montreal and Vancouver.

With a solid foundation of capabilities and world-leading expertise, Canada will secure environment and economic benefits as hydrogen and fuel cells move toward mass commercialization.



Canadian technology is part of the largest volume order of units to date – 200 forklifts – H2/FC technology has likely affected your daily life, whether you know it or not.

Before consumer hydrogen and fuel cell products are widely available to the general public, the technology will have a key role behind-the-scenes distributing various goods and products around the world.

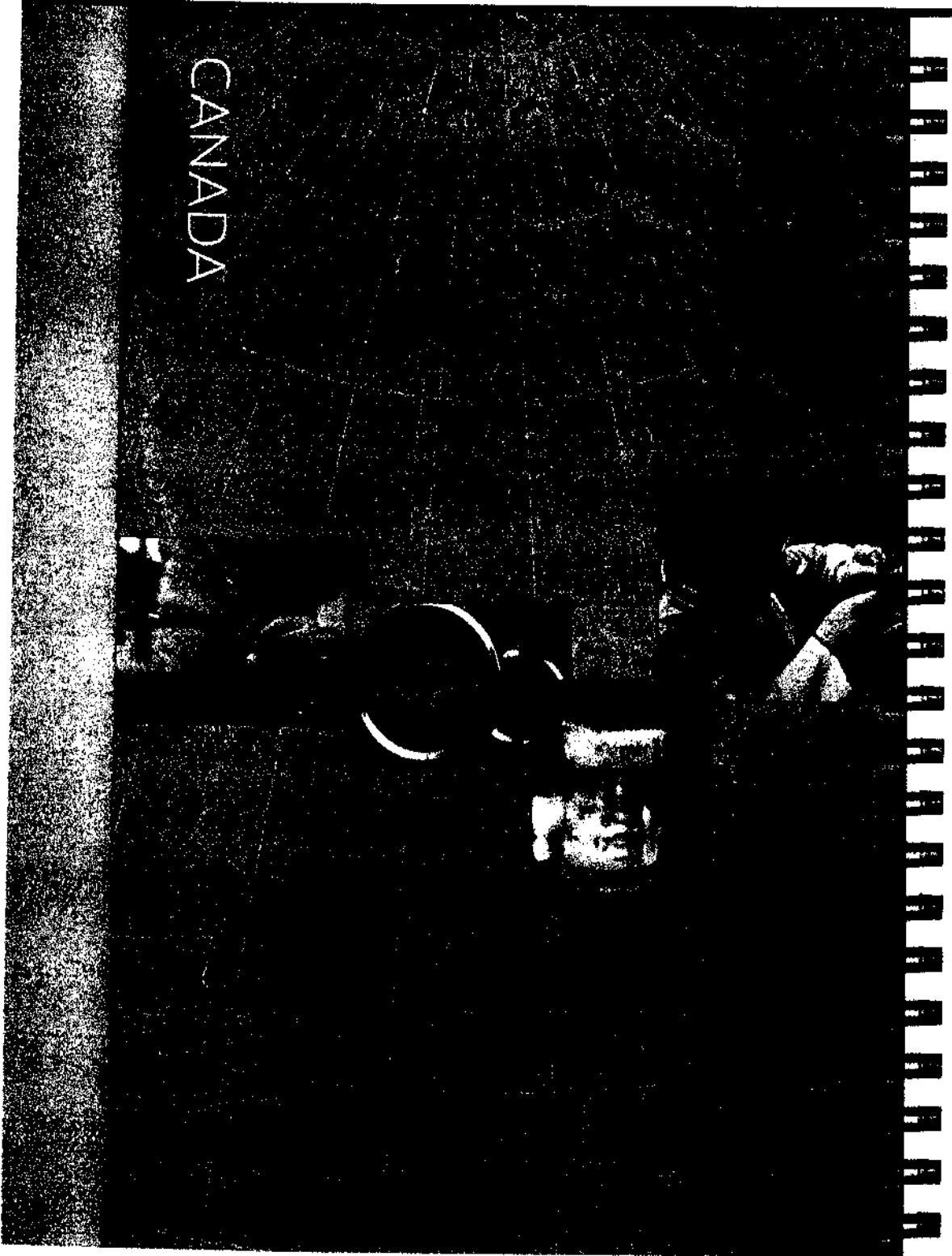
Forklift trucks and other material handling applications provide important advantages over conventional lead acid battery technologies:

- INCREASED PRODUCTIVITY – Fuel cell solutions offer longer operating times and reduced battery changing and charging requirements.
- NO SPACE REQUIREMENTS – Hydrogen and fuel cells allow warehouses and factories to set aside space normally allocated for battery storage and charging.
- CONSTANT POWER – Fuel cells provide constant power between energy refills – lead acid batteries, resulting in further productivity improvements.

With an estimated 2,000,000 forklift trucks in operation in North America, the material handling market is very attractive and Canadian companies are at the forefront of providing technology solutions.

Hydrogenics Corporation is actively engaged in the development, commercialization, marketing and distribution of fuel cell solutions for forklifts. Hydrogenics has demonstrated real world deployments at General Motors of Canada's Car Assembly plant and FedEx's logistics hub at the Pearson International Airport, where fuel cell powered forklifts were used in day-to-day operations.

Plug Power Canada's hydrogen fuel cell based power products are focused on early adopter customers in the warehouse food distribution and mass merchandising sectors. Their products utilize Ballard fuel cells and are field tested and proven at customer sites across North America.



Academia, government and industry are collaborating to commercialize hydrogen and fuel cell technologies.

The range of hydrogen and fuel cell R&D in Canada is extensive and diverse. The benefits of collaborative R&D are numerous and partnerships with government, industry and academia continue to advance hydrogen and fuel cell technology in Canada and support commercialization.

There are several important collaborative efforts between government, industry and academia.

- The National Science and Engineering Research Council (NSERC) is supporting a national network on hydrogen production, storage and safety led by the Université du Québec à Trois-Rivières and its Hydrogen Research Institute. Fourteen Canadian universities along with industry members participate in this network.

- In Ontario, the Fuel Cell Research Centre, FCRC (a venture between Queen's University and the Royal Military College) has partnerships with Canadian companies such as Ballard Power Systems, Hydrogenics and Quest Air Technologies to conduct R&D and address the key challenges and barriers to hydrogen and fuel cell commercialization.

- Solid Oxide Fuel Cells Canada (SOFC Canada) is providing guidance for SOFC research underway in Canadian research laboratories. This network links national research activities under an umbrella organization and provides a unified interface between the research community and industry.

- In British Columbia, the National Research Council Institute for Fuel Cell Innovation (IFCI) maintains close ties with the Clean Energy Research Centre (CERC) at the University of British Columbia and Simon Fraser University for developing advanced research capabilities in hydrogen and fuel cells for clean and sustainable energy systems. IFCI also collaborates with industry and offers hydrogen laboratories and a large scale environmental chamber for use by industry.

- A Proton Exchange Membrane (PEM) national network of academia and industry is being formed by Waterloo University in Ontario to advance R&D in this fuel cell platform.

- Collaborative research efforts between the Institute of Integrated Energy Systems at the University of Victoria (IESVic) and leading Canadian and international industrial partners are driving research on hydrogen and fuel cell technology, analysis and integration of sustainable energy systems.

The BC Hydrogen Highway is moving in the right direction – supporting the development, demonstration and deployment activities of its members

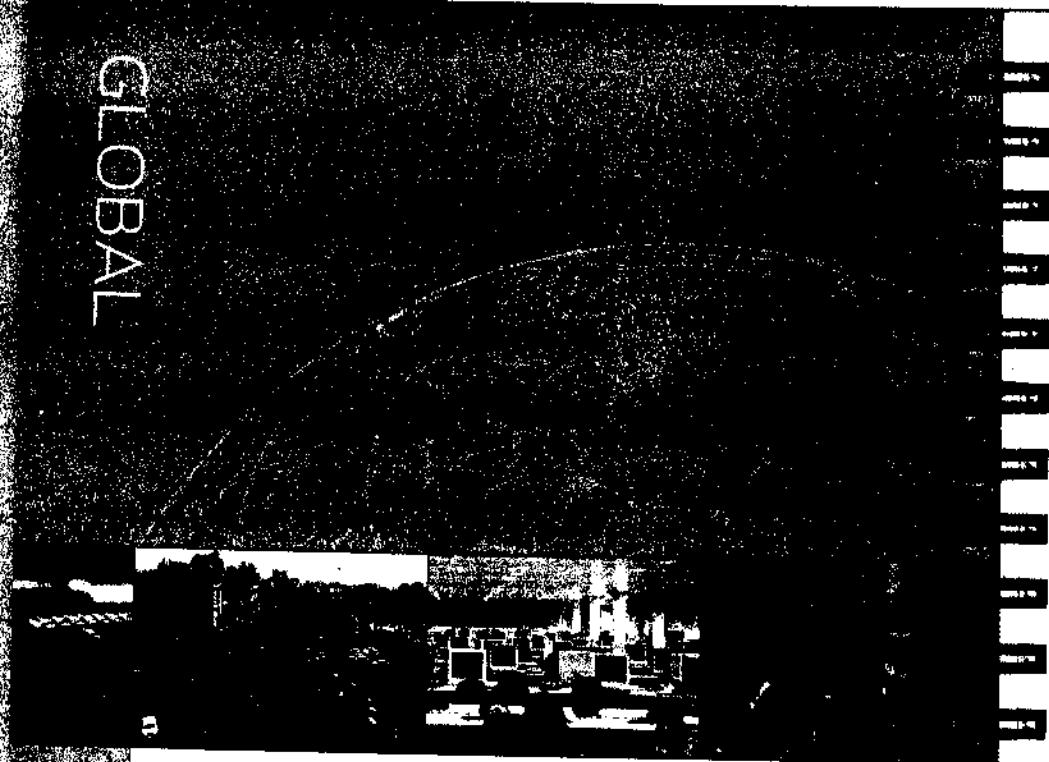
In addition to valuable funding for demonstration and deployment projects that comprise the Hydrogen Highway, the co-ordination and services made possible through Natural Resources Canada have allowed the Hydrogen Highway to become a brand identity for the British Columbia hydrogen and fuel cell sector.

The Hydrogen Highway helps to sustain the existing technology cluster in BC and creates links and alliances with other hydrogen highways internationally. It is a "touch stone" for those seeking information on hydrogen and fuel cell technologies and a portal for information to key audiences to facilitate commercialization process.

With a base of projects including fueling stations, micro hydrogen, transportation and stationary power applications, the next step is to expand fueling stations and attract further vehicles to use the available hydrogen.

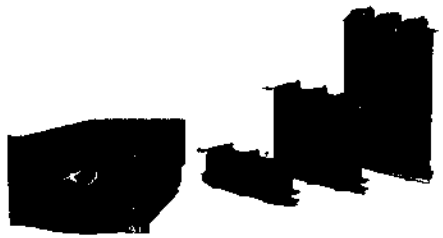
Deployment of Fuel Cell transit buses in Victoria and Whistler by 2010 will create the world's largest fleet of hydrogen fuel cell buses and accompanying fueling infrastructure, and is seen as a cornerstone of BC's Hydrogen Highway.

GLOBAL



BALLARD POWER SYSTEMS IS PARTNERING WITH DATEC ELECTRONICS AND ACME GROUP TO SUPPLY 5KW NATURAL GAS FUEL CELL PRODUCTS FOR TELECOM BACKUP POWER APPLICATIONS IN INDIA

A SUPPLY AGREEMENT PROVIDES A BINDING COMMITMENT FOR THE PURCHASE OF APPROXIMATELY 1,000 FUEL CELL UNITS IN 2009 AND 9,000 UNITS IN 2010, SUBJECT TO MEETING PRODUCT DESIGN AND ACCEPTANCE SPECIFICATIONS



Numerous Canadian companies are developing hydrogen and fuel cell power solutions that provide cost effective, reliable backup power for telecommunications infrastructure, data centers and other mission critical applications.

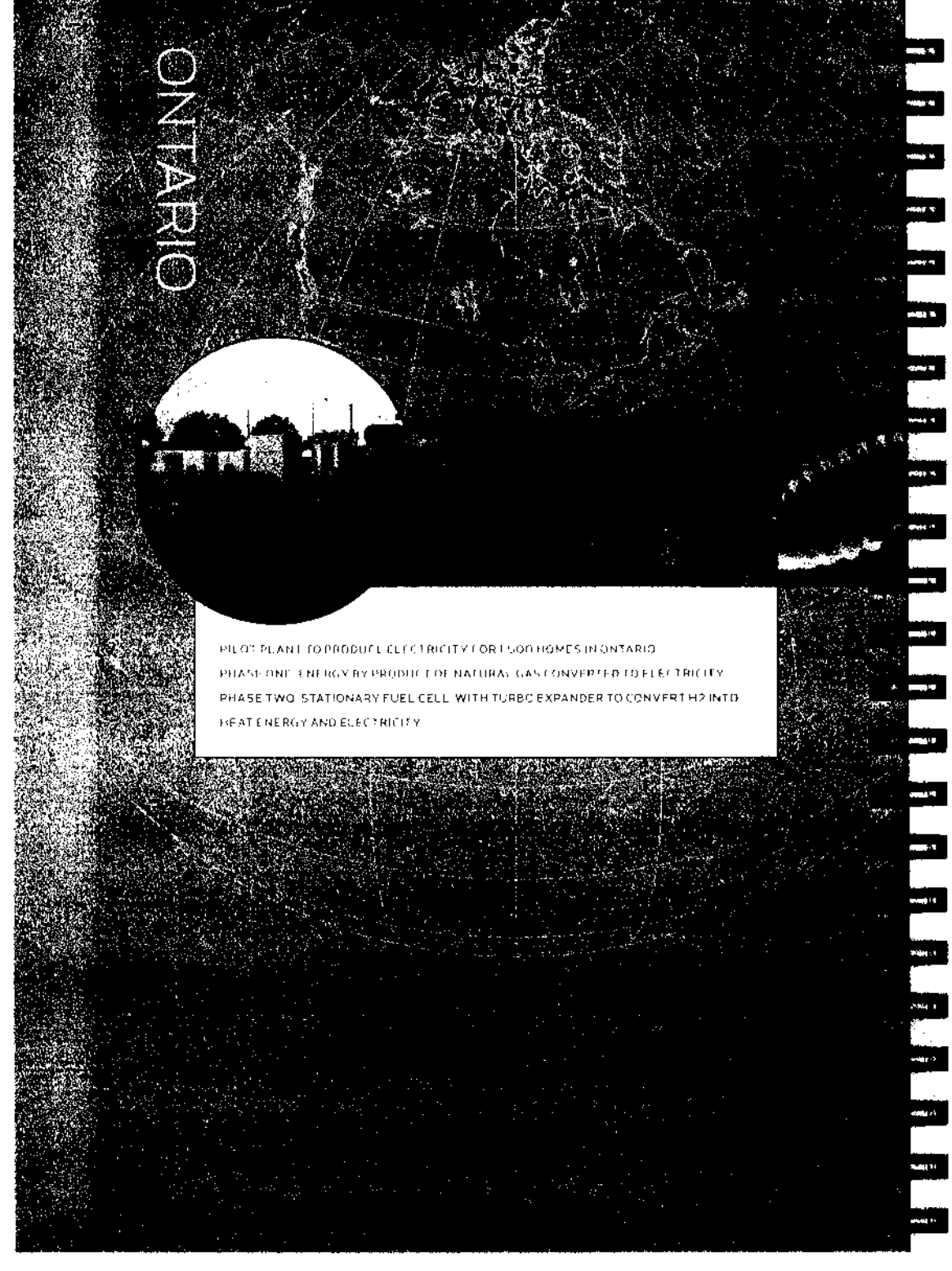
Backup power solutions based on fuel cell technology deliver a number of significant advantages over conventional batteries and diesel generators.

They feature high reliability, lower maintenance needs, longer operating life, and reduced size, weight, installation footprint, and environmental impact.

In addition, new government regulations mandating eight hours of backup operation time for emergency communication services help make fuel cell technology competitive with incumbent battery technologies.

With existing international partnerships with companies including Dantherm Power, India-based ACME Tele Power Ltd, and American Power Conversion, Canadian hydrogen and fuel cell companies are well positioned to support the demand of 75,000 units by 2010.

These significant commercial developments are setting new benchmarks for volume production that enable significant cost reductions, and demonstrate the commercial potential for hydrogen and fuel cells. The adoption of hydrogen and fuel cell technology continues and backup power applications are a critical volume commercial market for stationary power.



Fuel Cells are enabling the production of low carbon, low-emission electricity using natural gas. Here at home, Enbridge Gas Distribution is leading a unique project in Ontario's Hydrogen Village.

The widespread adoption of hydrogen and fuel cell technology depends on how well it integrates with a variety of energy sources such as natural gas. Residential stationary fuel cells selling now in Japan operate on local city gas.

This project is illustrating how fuel cell technology is providing clean fuel cell based power now using readily available natural gas.

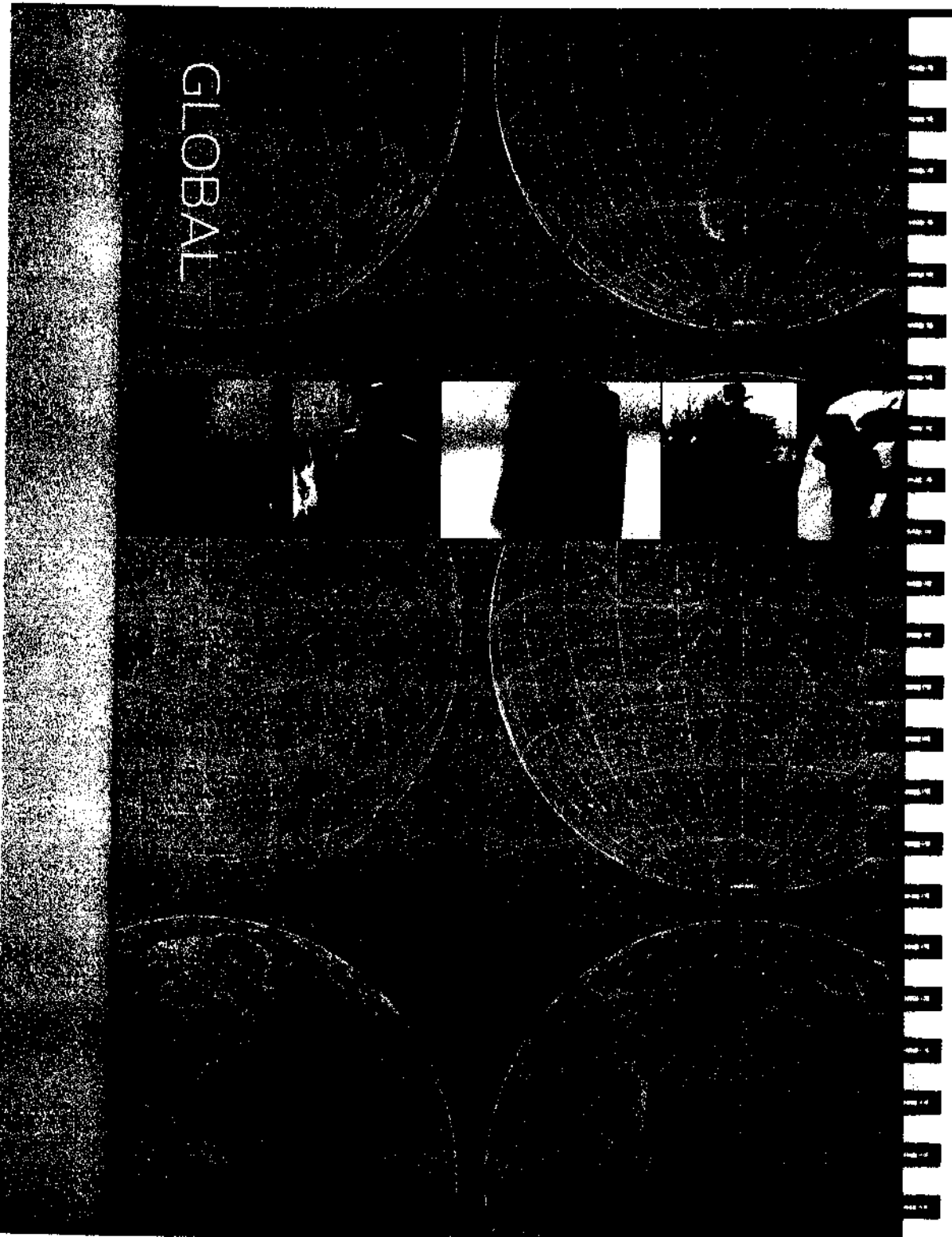
The leading edge natural gas hybrid fuel cell pilot plant integrates two proven, low-carbon technologies and integrates them for increased environmental benefits. Located in Toronto, it maintains a low profile, and will eventually produce 2.2 megawatts of electricity. That's enough energy to power 1,500 homes.

Phase One of the project will use a turbo expander to produce electricity as a by-product of day-to-day operations. For safety reasons, utilities squeeze natural gas through a valve to reduce pressure for distribution to homes and businesses. A generator converts the resulting pressure energy of the natural gas into electricity and the natural gas continues to flow to homes and businesses.

Phase Two will integrate a different environmentally sustainable technology – a stationary fuel cell with the turbo expander. A chemical reaction will convert natural gas to hydrogen and then convert the hydrogen into heat energy and electricity.

The heat energy is used to offset boiler emissions from Enbridge's operations and the electricity produced by the turbo expander. The fuel cell will operate without combustion, achieving near-zero smog emissions. It's efficient because it generates minimal greenhouse gas emissions and its only other by-product is water vapour.

The combination of these two technologies is a global first – as well as a clear example of how hydrogen and fuel cell technology can directly link with existing natural gas supplies.



The potential for hydrogen and fuel cells is big—but it all starts very small, literally. Fuel cells for powering portable devices such as cellular phones, laptops and flashlights are an early market for hydrogen and fuel cell products.

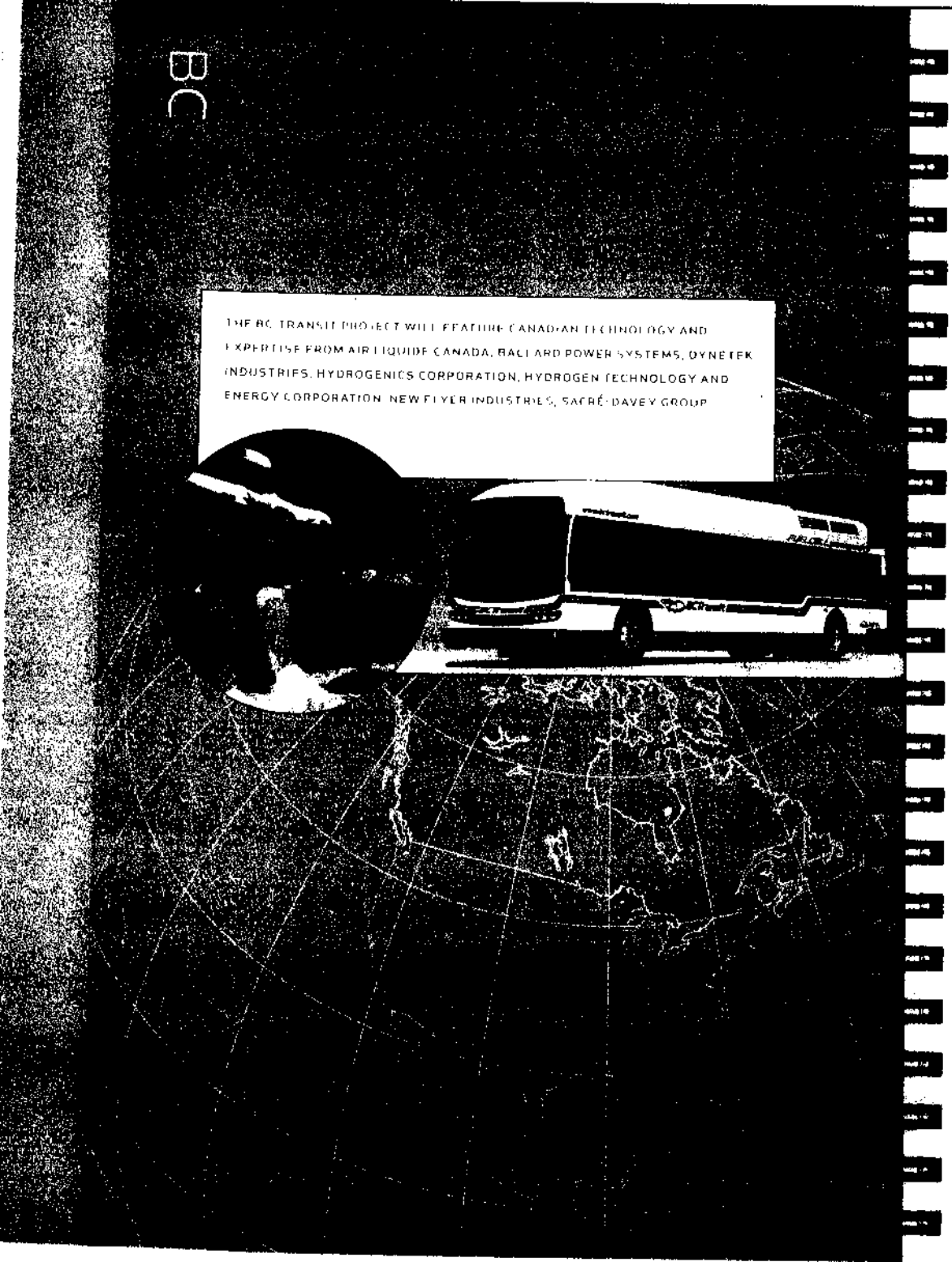
They can run on a variety of fuels, including, Formira™ (purified and modified formic acid), hydrogen and methanol. They are an exciting opportunity for everyday consumers to witness the numerous benefits that hydrogen and fuel cells provide.

As portable electronic devices continue to miniaturize and functionality increases, conventional batteries are reaching the limit for their ability to provide power. In this regard, fuel cells have many advantages over conventional batteries. They can be smaller and lighter and feature higher energy densities than batteries. Fuel cells also require less time to refuel or exchange than batteries do to recharge. For instance, a hydrogen cylinder can be refilled in a fraction of the time a battery needs to recharge.

Two Canadian companies are developing innovative solutions for portable power.

Tekion is integrating advanced battery technology with a unique micro fuel cell technology to create a new "personal power source" known as a Formira Power Pack, that will be capable of fitting inside mobile devices. By utilizing the unique characteristics of the Formira fuel, Tekion has created two "personal power source" product lines capable of being integrated into portable electronic devices or as an external power source.

Angstrom Power is developing micro hydrogen™ fuel cell technology for portable power. Their fuel cell systems enable high energy density power sources in small form factors suitable for portable devices, such as mobile phones. All benefit from the high power, long run times and fast recharge capabilities that micro hydrogen systems provide.



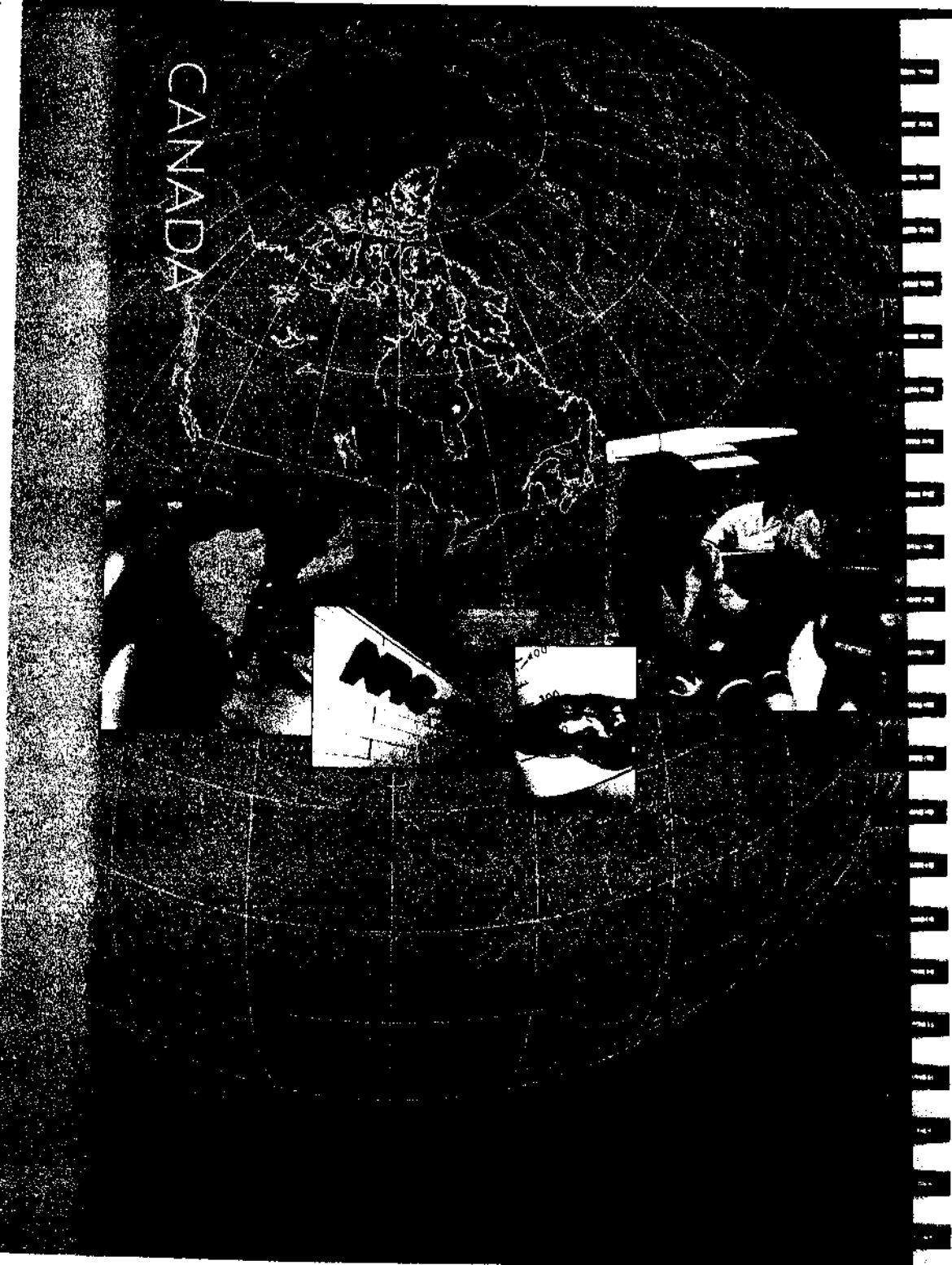
BC Transit – leading the way to cleaner air

BC Transit is championing the world's first hydrogen hybrid fuel cell bus fleet for urban mass transit in revenue service. Fully implemented for the 2010 Olympic and Paralympic Winter Games, the program will operate a fleet of 20 buses in Whistler. A federal-provincial partnership will invest $89 million for the entire program, including hydrogen fueling. BC Transit, a provincial crown agency, coordinates the delivery of public transportation to 87 transit systems throughout British Columbia and has a fleet of over 860 vehicles.

The goal is to demonstrate for the first time the integration of fuel cell buses into the regular operational service of an urban transit system, allowing monitoring of operations, maintenance and fueling over a sustained period.

The development of a hydrogen bus fleet contributes to BC's commitment to fuel cell technologies and the Hydrogen Highway as part of the overall plan to cut greenhouse gas emissions by 33 per cent by 2020. This initiative will showcase Canadian technologies and prove to people around the world that hydrogen and fuel cell bus fleets offer the service and reliability they expect from their transit service.

Public transit is already an environmentally responsible option, efficiently moving people in urban communities. Hydrogen fuel cells are a source of energy that produces zero emissions. Hydrogen transit fleets increase the already existing health, social and environmental benefits from public transit.



Collaboration is second nature to the National Research Council (NRC). As the Government of Canada's premier organization for research and development, NRC partners with industry, academia and other government departments to create breakthrough innovations contributing to the global competitiveness of Canadian industry.

The results: new knowledge, new skills, new partnerships and new businesses that are boosting the economy of Canada and its communities through success in markets around the world.

A CATALYST FOR INNOVATION

In the area of hydrogen and fuel cell technology, the Vancouver-based NRC Institute for Fuel Cell Innovation (NRC-IFCI) is dedicated to advancing industry commercialization through its research, demonstration, and validation programs. Serving as a networking centre and innovation hub for the regional fuel cell cluster, NRC-IFCI currently incubates 11 SMEs as part of NRC's Industrial Partnership Facility program.

NRC is also working to integrate fuel cell technology in key sectors of the Canadian economy, such as the automotive, aerospace, and construction sectors. Joint programs like the NRC Construction Sector Initiative are overcoming barriers to the integration of hydrogen and fuel cell technologies into Canadian buildings.

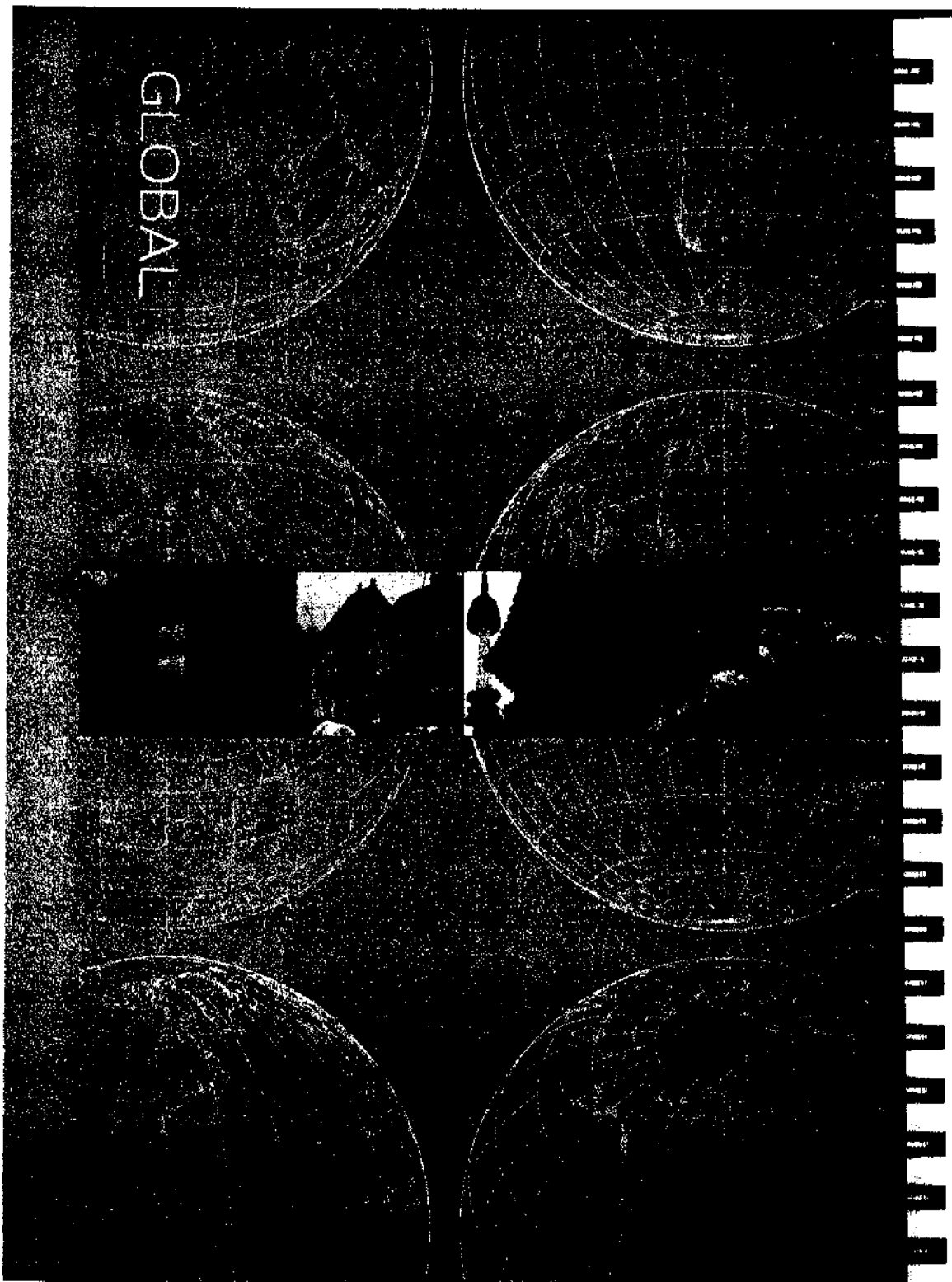
Through the Hydrogen and Fuel Cell National Program, a joint initiative that NRC-IFCI coordinates with NSERC and NRCan, NRC is now uniting a critical mass of government, industry, and academic stakeholders behind large-scale projects in priority areas. Ground-breaking Technology Development Projects (TDPs) have been designed to give Canadian companies a competitive advantage in next-generation proton exchange membrane (PEM) and solid oxide fuel cell (SOFC) technology.

BLAZING A TRAIL

These collaborative efforts are paying off. Canada ranks first in fuel cell research on a per capita basis and stands first in its scientific impact. Canada is also recognized as holding the most advantageous position in fuel cell intellectual property, with the country's patents recognized as offering above-average technological impact and specialization.

Within Canada, NRC ranks among the top 10 institutes in the world in terms of the impact of its publications. NRC-IFCI and its regional university partners are recognized as one of the world's most important centres of research collaboration.

This success is not accidental, but the result of a deliberate strategy to specialize in selected technologies and core competencies, build critical infrastructure, leverage resources and build expertise through strategic collaborations. Powered by partners, NRC is delivering results.



All eyes are on Canadian hydrogen and fuel cell innovations.

Canada's hydrogen and fuel cell industry sector is generating global interest with the assistance of the Canadian Trade Commissioner Service (TCS). Several companies have attracted international attention due to the role that Trade Commissioners play in supporting this unique Canadian sector. For example:

- Ballard Power Systems and Hydrogenics are both working with Japanese partners to supply cogeneration power units that deliver electricity and heat to Japanese homes.
- Ballard fuel cell stacks are integrated into lift trucks, backup power and uninterruptible power supplies by foreign suppliers in India, Denmark, China, the USA and other countries.
- Hydrogenics has had global business in the sale of electrolysers for hydrogen production for many years and is now beginning to see its fuel cells deployed in international markets.
- QuestAir Technologies exports hydrogen purification systems to the USA, Japan, Indonesia, Korea and other countries.
- Dynetek Industries is a major supplier of high pressure hydrogen storage tanks to global hydrogen vehicle programs.

The Department of Foreign Affairs and International Trade promotes the hydrogen and fuel cell industry in other ways as well. For example, under the bilateral science and technology agreements, the Innovation, Science and Technology Division facilitates the collaboration between Canadian researchers and their colleagues in countries such as Brazil and India.

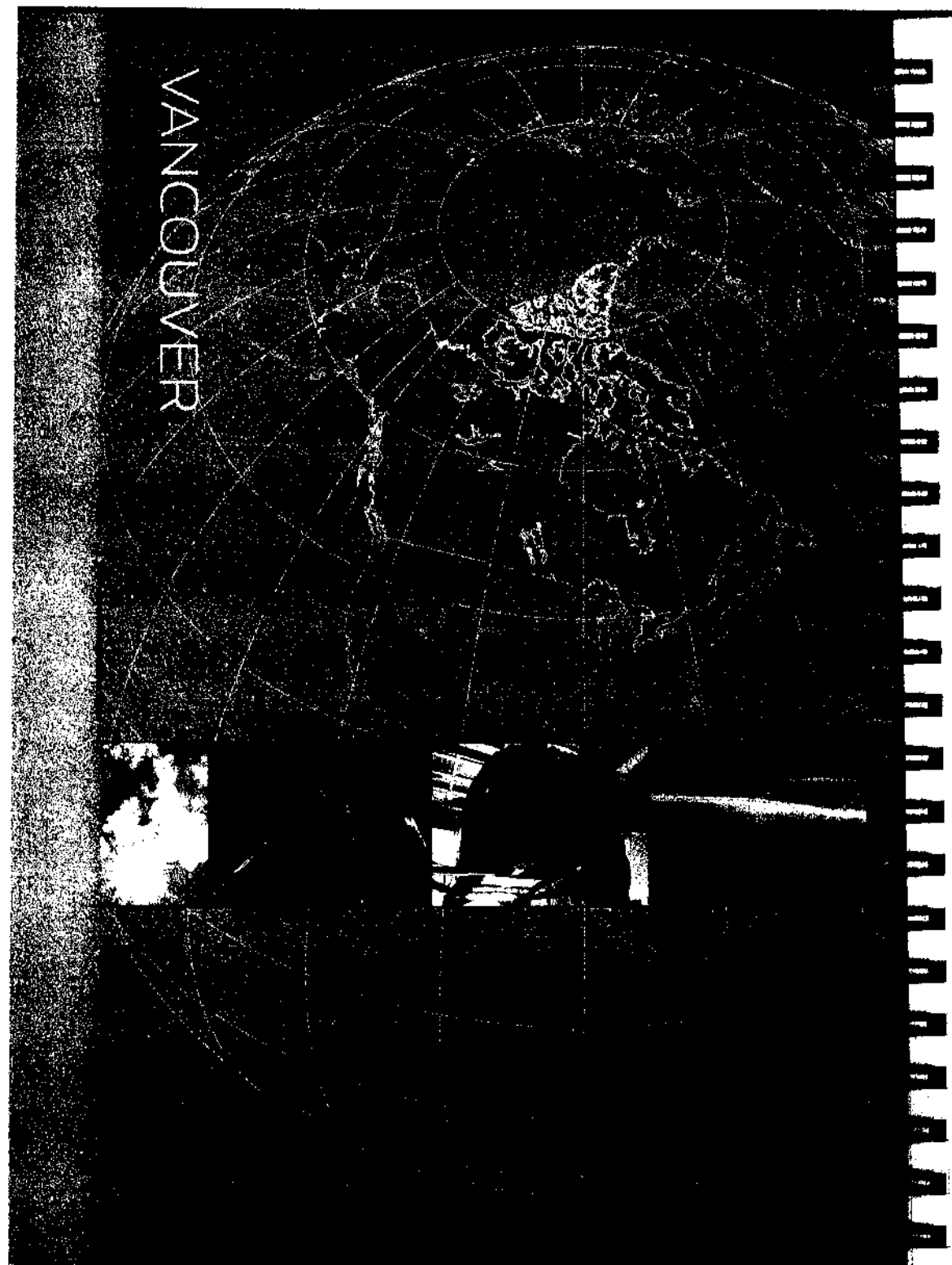
ABOUT THE CANADIAN TRADE COMMISSIONER SERVICE

As part of the Foreign Affairs and International Trade Canada (DFAIT), the Canadian Trade Commissioner Service (TCS) promotes the country's economic interests abroad, and plays a valuable role in supporting the Canadian hydrogen and fuel cell industry sector on the global stage.

Located in over 150 cities worldwide and in 17 regional offices across Canada, the TCS is Canada's most comprehensive network of international trade professionals, offering expert advice, problem solving skills and a global network of contacts.

Visit tradecommissioner.gc.ca for more information on our key services.

VANCOUVER

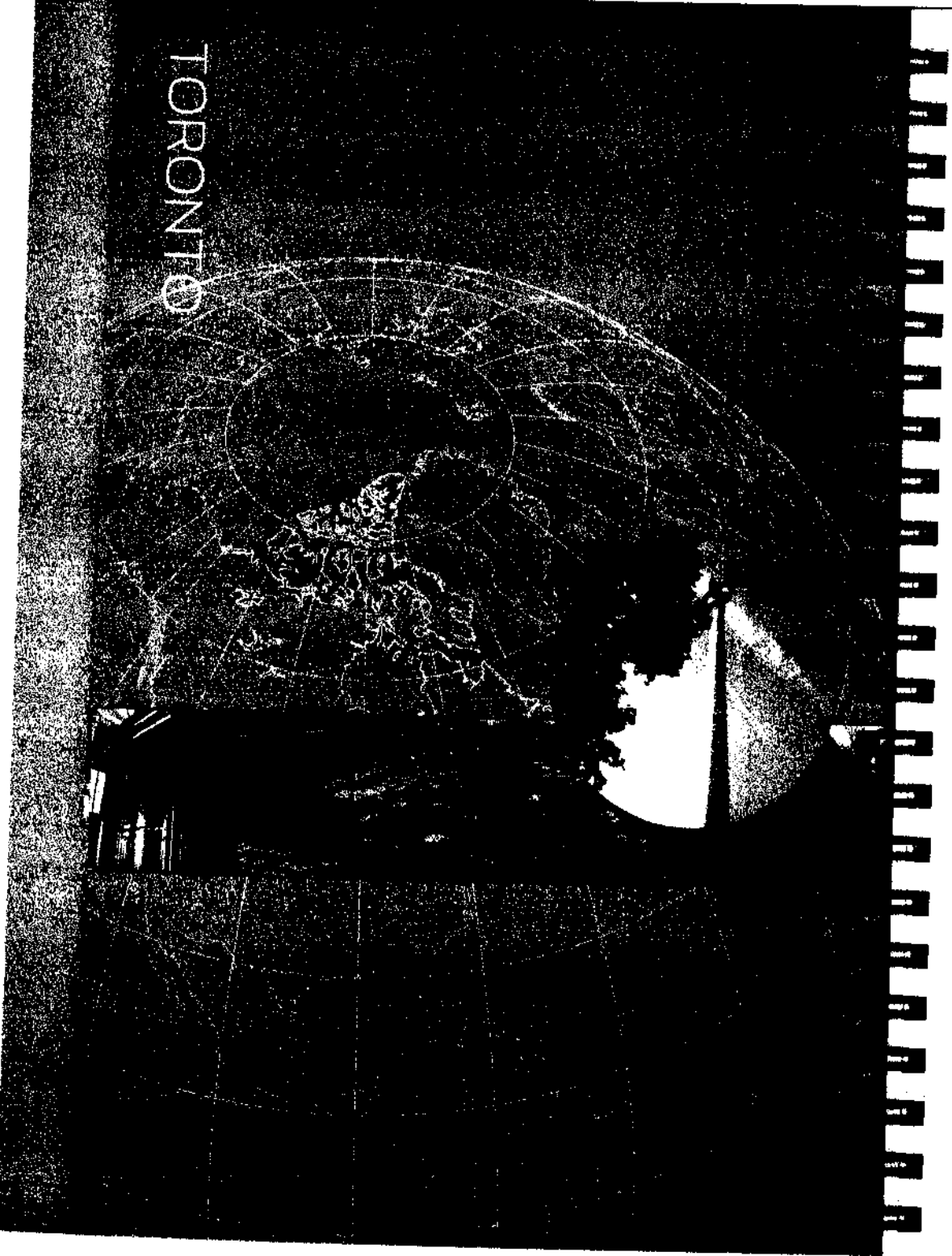


Canada is putting hydrogen energy in motion. In Vancouver and Victoria, British Columbia, an innovative program is putting fuel cell electric vehicles to work in real world settings.

As the first demonstration of fuel cell electric vehicles in Canada, the Vancouver Fuel Cell Vehicle Program is testing and evaluating five Ford Focus fuel cell electric vehicles for a period of three years. The vehicles use Ballard fuel cell engines and Dynetek hydrogen storage tanks, and were the first to use the fueling infrastructure and industry capabilities of British Columbia's Hydrogen Highway.

The program is contributing to the development of a sustainable, zero emission transportation system that will help reduce pollution and greenhouse gases. It is an opportunity to test and collect valuable information on fuel cell technology performance, durability and reliability that can be applied towards the development and evolution of consumer fuel cell vehicles.

The Vancouver Fuel Cell Vehicle Program is a three year, $6.7 million initiative between the Government of Canada, Hydrogen & Fuel Cells Canada, Ford Motor Company, and the Government of British Columbia.



Building hydrogen and fuel cell communities.

The Hydrogen Village is a collaborative public-private partnership from a broad cross-section of the sector accelerating the sustainable commercialization of hydrogen and fuel cell technologies. This partnership is driving early hydrogen and fuel cell deployments in the end user community within the Greater Toronto Area.

Examples of significant progress achieved to date include:

- The establishment of a refueling station at Exhibition Place that provides regular hydrogen refueling service to four John Deere Fuel Cell utility vehicles. Moving forward, the station will be the primary refueling point for a fleet of Ford hydrogen internal combustion shuttle buses.

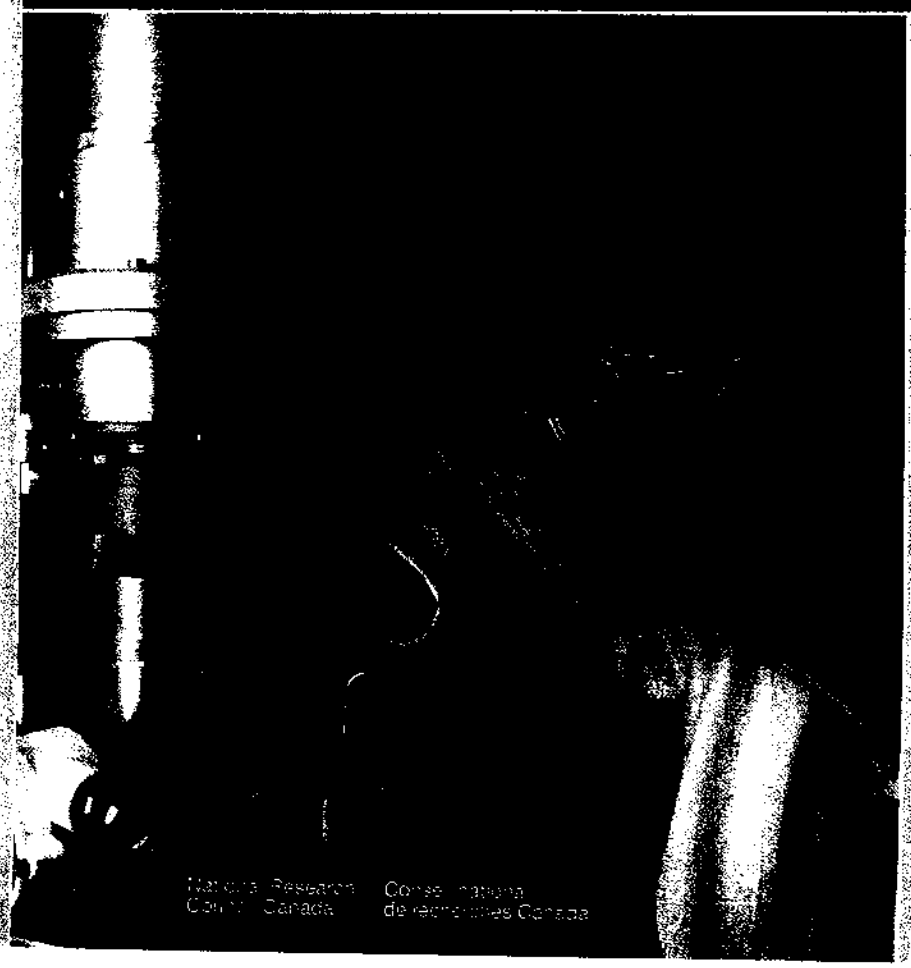
- Demonstration of a solid-oxide fuel cell installation at the University of Toronto at Mississauga. The installation provides base load power and heat for campus housing.

- The General Motors plant in Oshawa is taking the delivery of nineteen fuel cell powered forklifts, providing improved warehouse productivity and operational reliability. This deployment represents one of the largest fuel cell powered material handling deployments in the world and is a critical step toward commercialization in this market.

- Interlink Connectivity, an internet service provider, now operates a fuel cell back-up power system at its offices in Toronto. The fuel cell back-up power system is providing zero emission power and is able to accommodate the building's space and weight restrictions.

NRC·CNRC

Responding to the world's energy and environmental challenges is a priority in the Government of Canada's Science and Technology Strategy. Developing and commercializing hydrogen and fuel cell (H₂/FC) energy technologies in the Vancouver region is a core element of that response. NRC's early strategic investments have primed regional and national partners to seize a significant share of a global market that is projected to be worth over US$8.5 billion by 2016.



NRC Technology Cluster Initiatives 2009 — Community Innovation, Economic Gain

The National Research Council (NRC) is meeting the Government of Canada commitment to generate economic growth through support for scientific and technological innovation. NRC partners with universities, industry and all levels of government to build dynamic technology clusters in communities across the country. By fostering world-class R&D that's directly linked to stimulating economic opportunities, NRC research facilities and skilled people accelerate locally and globally. The results: new innovations, new ideas, new partnerships and new businesses that are boosting the economy of Canada and its communities through success in markets around the world.

Canada

Canada

Germany

Israel

Japan

Sweden

Taiwan

United Kingdom

United States

Arizona

California

Colorado

Connecticut

District of Columbia

US Department of Energy, Fuel Cell Technologies Program

Florida

Georgia

Massachusetts

Michigan

Minnesota

New Jersey

New Mexico

New York

North Carolina

Ohio

Oregon

Pennsylvania

Exhibitor by Country

South Carolina

Tennessee

Texas

Wisconsin

Wyoming

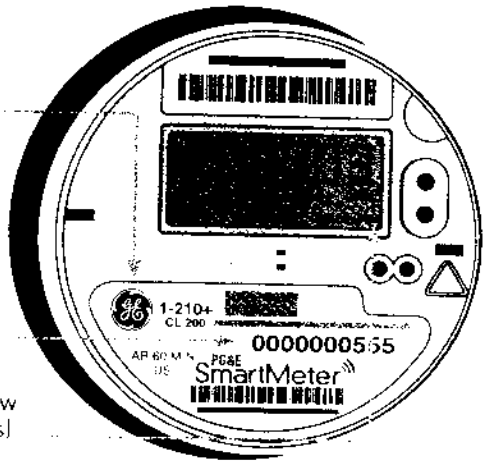
ADC Power

Exhibitor by Area of Expertise

CompanyName	Stationary	TelBackUpPower	Components	Testing	GovtIndAssoc
Advanced Fuel Cell Technology magazine (FCT)	XX	XX	XX	XX	XX
AMREL				XX	
Arbin Instruments				XX	
Azbil North America			XX	XX	XX
Ballard Material Products	XX	XX	XX	XX	
BASF Fuel Cell			XX		
Bosit NV			XX		XX
Brooks Instrument			XX		
Catacel Corp			XX		
CD-adapco				XX	XX
Cella Energy	XX	XX	XX	XX	XX
Center for Hydrogen Research				XX	XX
Center for Transportation and the Environment					XX
Cetech Co., Ltd			XX		
Connecticut Center for Advanced Technology, Inc					
Connecticut Clean Energy Fund					XX
Connecticut Department of Economic and Community Development (DECD) Office of Business and Industry Development					XX
Connecticut Hydrogen-Fuel Cell Coalition					XX
Dextrel Corporation			XX	XX	
ECS - The Electrochemical Society					XX
Entegris	XX		XX	XX	

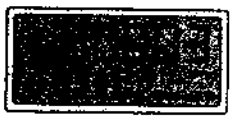
Welcome to the PG&E SmartMeter

How to read your new electric meter



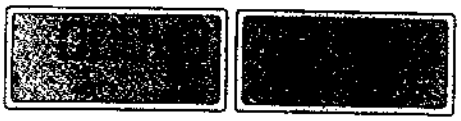
1. GE Logo:
   Confirm you have a GE-brand meter
2. Meter Number:
   This is the number shown in the Electric Account Detail of your energy statement under the heading Meter #
3. Digital Display Window:
   Check your energy use (see below and right for display descriptions)

Your GE SmartMeter™ electric meter automatically cycles through four displays.

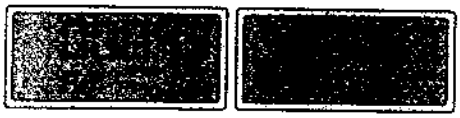


The **five-digit number at the top** is the amount in kilowatt hours (kWh) of energy you have used to date since the installation of the meter. For reference, if you leave a 100-watt light bulb on in your home for one hour per day for 30 days, the energy used is 100 watts x 30 hours = 3,000 watt hours or 3 kWh. The **three-digit number at the bottom** is the actual amount of energy you're using right now. For instance, 1.02 means you're using 1.02 kilowatts—or 1,020 watts.

The **number 88888** with all the elements lit verifies that the display is working properly. The **three-digit number at the bottom** is the actual voltage (or electrical potential) right now.

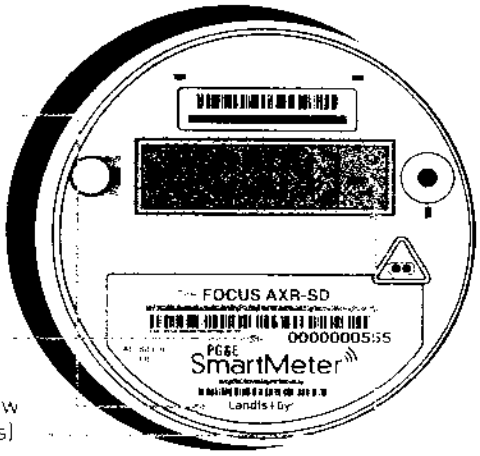


On indicates the switch is closed, and power is being delivered. **Off** indicates the switch is open, and power is not being delivered.



Adl (for Advanced Distribution Infrastructure) displays when the meter is communicating with the on-board SmartMeter™ module. **Delivered**, at the bottom right of the displays, indicates use. If there is no power being used, it doesn't display.

How to read your new Landis+Gyr electric meter



1. Landis+Gyr Logo:
   Confirm you have a Landis+Gyr-brand meter
2. Meter Number:
   This is the number shown in the Electric Account Detail of your energy statement under the heading Meter #
3. Digital Display Window:
   Check your energy use (see below and right for display descriptions)

Your Landis+Gyr SmartMeter™ electric meter automatically cycles through either three or five displays, depending on your model.

This **five-digit number** is the amount in kilowatt hours (kWh) of energy you have used to date since the installation of the meter. If you leave a 100-watt light bulb on in your home for one hour per day for 30 days, the energy used is 100 watts x 30 hours = 3,000 watt hours, or 3 kWh.

The **number 888888** with all the elements lit verifies that the display is working properly.

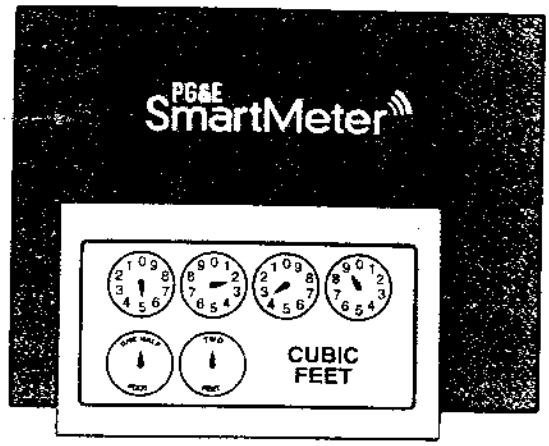
This **six-digit number** is the actual amount of energy you're using right now. For instance, 001.939 means you're using 1.939 kilowatts—or 1,939 watts.

VLT indicates voltage (or electrical potential) is being delivered. **CLS** indicates the switch is closed and power is being delivered. *These displays are not available on all models.*

VLT reading of zeros indicates voltage is not being delivered. **OPN** indicates the switch is open and power is not being delivered. *These displays are not available on all models.*

Read the bottom section on the back to find out how to track your hourly electric use online.

The SmartMeter™ gas **module** added between the meter and the rotary dials records daily meter reads and then transmits the reads to PG&E.



The odometer-like mechanical dials on your gas meter measure the therms of gas that hav traveled through the meter into your home.

Your gas meter uses multiple clock hands and typically has four dials to read. The first and third dials spin counter clockwise, while the second and fourth dials spin clockwise. When reading the meter, if the dial is between two numbers, use the lower number. For instance, the meter pictured here reads 5, 2, 3, 9.

The two dials without numbers are used by PG&E when testing the meter for accuracy.

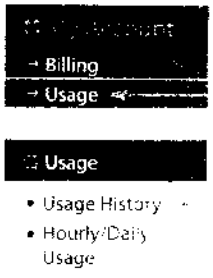
Read the next section to find out how to track your daily gas use online.

Now for the first time ever, you can see exactly how much gas and electricity you're using up to the previous day and when you're using it. Knowing how much energy you're using puts you in control of your energy use, and allows you to make smarter energy choices.

With SmartMeter™ technology, you can track your energy use history online. If you don't already have an online account, you can set one up in just a few minutes:

- Go to: www.pge.com/myaccount
- The first time, you will click on '**Sign Up**'
- Fill in the required information. You'll need your PG&E account number and the primary phone number on your account.

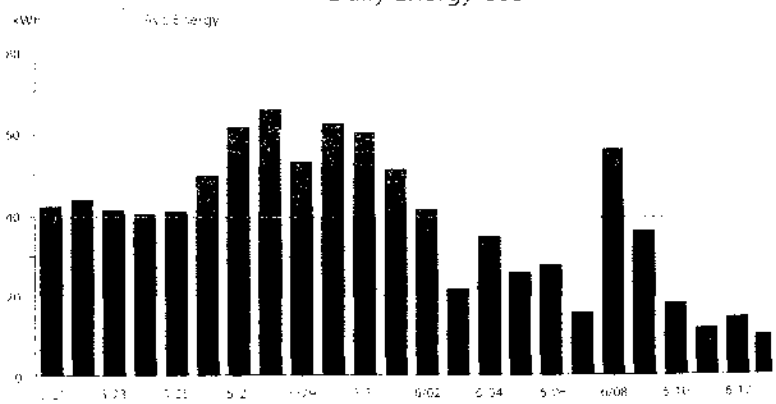
Once you've established your online account, you can '**Login**' and access your gas and electric energy use history right up to the previous day at www.pge.com/myaccount



Once you've logged in, click on '**Usage**' on the left navigation bar.

Select '**Usage History**' to see your month-by-month energy use and compare your monthly bills. Clicking on '**Hourly/Daily Usage**' will show you hour-by-hour electric or day-by-day gas energy use information (example shown below).

Daily Energy Use



For more information about the SmartMeter™ program, visit www.pge.com/smartmeter or call 1-866-743-0263.

CDR-0210-0391