Photovoltaics and the Transition to a Carbon-Neutral Energy System in Canada*

Policy Brief

A Strategy for Building-Integrated Photovoltaics in Canada

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Introduction

Solar photovoltaic (PV) technologies have become an increasingly important part of the global energy landscape over the past several years. As jurisdictions around the world continue to encourage the deployment of PV systems, module costs have plummeted and vastly improved the competitiveness of PV. As a result, the PV market has grown immensely, reaching $93 billion in global revenues and surpassing 29GW of installed capacity in 2011[1]. The total global capacity for PV installations now amounts to 69.7GW[2] with fairly robust growth expected in the future[3]. In this growing market, leading jurisdictions have seen their domestic PV industries flourish: California`s solar sector employs nearly 50,000[4], while Germany`s exceeds 110,000[5] and Ontario`s surpasses 8,000[6].

However, more recently, the PV industry has experienced turbulent times with prominent bankruptcies overshadowing successes. As the market continues to mature and government support is dialed down, consolidation is expected to intensify and firms will need to innovate even more aggressively in order to succeed. Additionally, potentially disruptive PV technologies are emerging and prompting discussion around future system designs and appropriate policy support. Governments, hoping to promote industrial development and deploy clean energy systems, are faced with navigating the challenges and opportunities presented by this rapidly shifting industrial landscape.

Consequently, if Canadian jurisdictions are to succeed in this changing market and rollout modern energy systems, it is time to consider the potential benefits surrounding novel PV applications – in particular, building-integrated PV (BIPV) – and devise an appropriate strategy for unlocking these benefits. This brief will explore the potential societal benefits surrounding BIPV and propose a series of policy options.

What is BIPV?

BIPV technologies can be installed on new or existing buildings to generate electricity. They are integrated into – rather than merely added onto – buildings, replacing materials needed for roofs, skylights, facades, curtain-wall on high risers, and parking canopies, among other applications.

Why is BIPV important for Canada?

Canadian jurisdictions are faced with increasing challenges related to electricity generation, transmission and distribution. The expansion of grid infrastructure to meet rising demand and the modernization of aging electricity systems are placing unprecedented cost burdens on utilities and ratepayers. Costs associated with grid maintenance and expansion are expected to reach nearly $300 billion over the next

[1] NPD Solarbuzz (2012). *Marketbuzz Annual PV Market Report.* Online: http://www.solarbuzz.com/news/recent-findings/world-solar-photovoltaic-market-grew-274-gigawatts-2011-40-yy (accessed July 25, 2012).
[2] European Photovoltaic Industry Association – EPIA (2012), *Global Market Outlook for Photovoltaics Until 2016*.
[3] EPIA (2012). *Global Market Outlook for PV until 2016*. Online: http://files.epia.org/files/Global-Market-Outlook-2016.pdf (accessed August 20, 2012).
[4] Lindstrom, E., & Marquez, M. (2012). *Solar Industry & Occupations*. Centers of Excellence.
[5] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – BMU (2012). *Gross employment in renewable energy in 2011*.
[6] ClearSky Advisors (2011). *Economic Impacts of the Solar PV Sector in Ontario 2008-2018.* Online: http://www.cansia.ca/sites/default/files/economic_impacts_of_the_solar_photovoltaic_sector_in_ontario_2008-2018_july_26_0.pdf (accessed July 25, 2012).

two decades[7]. The built environment is a critical area for electricity consumption and GHG emissions, with buildings accounting for about half of Canada's electricity consumption and nearly one third of Canada's energy-related carbon emissions. Additionally, the built environment is responsible for large swings in electricity use which compounds challenges for utilities in efficiently balancing supply and demand.

BIPV represents an opportunity to mitigate many of these challenges by reducing peak loads (since BIPV often generates electricity when demand is highest) and generating electricity at the point of consumption, reducing the reliance on the grid. In effect, the deployment of BIPV technology results in a double dividend as consumers save on utility costs while utilities benefit from forgoing costly investments in additional peaking generation and grid expansion.

BIPV also presents a series of industrial development opportunities for Canada. Historically, Canada has been a leader in building construction, and the marriage of this sector with the growing capacities in PV installations – particularly in Ontario – represents an area where Canadian industries could become world leaders. By focusing on BIPV applications for northern climates for instance, Canada could leverage its capacities in both building construction and PV to gain a comparative advantage in the fabrication of specialized BIPV materials. Benefits flowing from these activities would include job creation along with the expansion of the construction industry. Under an appropriate policy regime, the domestic BIPV industry would have the opportunity to create export capacity and benefit from the rapidly increasing adoption of PV worldwide.

Although some of the benefits presented above could be achieved through the deployment of rooftop PV systems, BIPV offers a variety of benefits over and above both traditional materials and conventional rooftop PV. Unlike standard PV, the additional costs associated with BIPV are partially offset by the cost of the building materials this technology replaces. And, in many cases, BIPV outperforms traditional construction materials in terms of both technical parameters and maintenance. For instance, BIPV systems are designed to last for over 25 years, whereas asphalt roof shingles last for 17-20 years[8]. BIPV does not require expensive racking systems like regular solar panels nor does it require additional land. Furthermore, BIPV provides many aesthetic advantages over standard materials and traditional roof-mounted PV.

Government support is critical if these potential benefits are to be realized as BIPV materials remain costly and in early stages of development. PV support policies have recently shown that they can be effective in promoting industrial development, encouraging deployment and triggering innovation. Under an appropriate policy framework – consisting of a portfolio of incentives, R&D support and regulatory changes – similar circumstances could emerge for BIPV.

[7] Baker, B., Skolkin, I., Coad, L. & Crawford, T. (2011). *Canada's Electricity Infrastructure: Building a case for investment*. Ottawa: The Conference Board of Canada.
[8] James, T. et al. (2011). *BIPV in the residential sector: an analysis of installed rooftop systems*. Golden: National Renewable Energy Laboratory.

BIPV Potential in Canada

Current Progress on BIPV

In Canada, policy support for the deployment of solar PV technologies and materials is mostly limited to Ontario, where the Green Energy and Green Economy Act of 2009 ushered in the creation of a feed-in tariff (FIT). The FIT guarantees, through 20-year contracts, a generous fixed rate for electricity generated by eligible renewable sources. Support in other provinces is limited to net-metering arrangements, whereby renewable energy generators are permitted to sell excess electricity (their production, net of their own consumption) to the grid. PV deployment under net-metering is not currently economically justifiable – in part due to Canada's relatively low-cost electricity – and therefore installed capacity is nearly entirely isolated to Ontario.

Existing support policies, including Ontario's, do not contain incentives specific to BIPV. In fact, under a regular FIT scheme, BIPV is somewhat discouraged because the incentive structure favours the cheapest available technology at any given time in order to maximize returns. Clearly, the policy framework surrounding BIPV must be revisited if Canada is to rollout this technology in a fashion consistent with unlocking economic opportunities, realizing meaningful carbon emission reductions and mitigating electricity system challenges.

BIPV Potential in terms of Electricity Supply and GHG Reductions

BIPV has significant potential for realizing GHG reductions in Canada. According to a study by CanmetENERGY,[9] 46% of Canada's residential electricity needs could be met by BIPV installations, whereas 15-17% of the electricity consumed by commercial and institutional buildings could be supplied by BIPV systems. Overall, this amounts to approximately 29% of annual electricity consumption by these sectors, which together represent over half of the total electricity consumption in Canada. The corresponding potential annual GHG reductions amount to 23 megatonnes. These numbers represent conservative estimates of the total potential energy that could be supplied by BIPV, given that they do not account for synergies with thermal systems and possible heat recovery from BIPV[10].

Economic Opportunities

Total BIPV installations around the world reached 1.2 GW in 2010[11]. The global market is expected to reach roughly $606 million in 2012 and is anticipated to realize significant growth over the next four to five years. Estimates indicate that the BIPV market will likely expand to more than $2.4 billion dollars by 2017[12]. As costs decrease, installations are projected to rise to nearly 4.6 GW in 2017.

[9] Pelland, S. & Poissant, Y. (2006). An evaluation of the potential of BIPV in Canada. Varennes: CanmetENERGY.
[10] Chen, Y., Athienitis, A.K. & Galal, K. (2010). "Modeling, design and thermal performance of a BIPV/T system thermally coupled with a ventilated concrete slab in a low energy solar house: Part 1, BIPV/T system and house energy concept", Solar Energy, 84(11), 1892-1907.
[11] BCC Research (2011). *Building-Integrated Photovoltaics (BIPV): Technologies and Global Markets*, Online: http://www.scribd.com/doc/85016610/Building-Integrated-Photovoltaics-BIPV-Technologies-and-Global-Markets (accessed August 3, 2012).
[12] Pike Research (2012). *Building Integrated Photovoltaics Market Revenue to Quadruple to $2.4 Billion by 2017*, Online: http://www.pikeresearch.com/newsroom/building-integrated-photovoltaics-market-revenue-to-quadruple-to-2-4-billion-by-2017. (accessed September 2, 2012).

This growing global market presents an opportunity for Canada to develop a promising BIPV industry capable of competing both domestically and internationally. Since this technology is most beneficial when adapted for varying architectural and design demands as well as climactic conditions, there is less opportunity for jurisdictions with low cost manufacturing advantages to capture the entire global market. In other words, the commodification of BIPV – as has been the case for PV cells and modules in recent years – is unlikely to be realized to the same extent. And, Canada's relevant industrial advantages (skilled workforce, top researchers in the field, leading construction industry, relatively low cost and clean electricity, etc.) are well suited to this industry. Leveraging these advantages along with unlocking potential synergies between BIPV and construction industries in Canada will determine the success of attempts to develop a domestic BIPV industry. If an appropriate support framework can be implemented to facilitate technological and industrial innovation, there is a genuine opportunity for Canadian firms to play a leadership role in the growing BIPV market.

International Efforts

France

Although several countries have implemented policies to encourage PV deployment in the past decade, France has distinguished itself as a leader in BIPV. After introducing a FIT for renewable electricity generation in the early 2000s, the French government implemented a premium for all forms of building integration in 2006. With the introduction of that premium, France made a clear statement about their preferred solar energy application. In comparison to efforts by other jurisdictions, incentives in France were far more generous at almost double the FIT rate for regular panels (0.55 €/kWh vs. 0.30 €/kWh). In 2010 France went even further by differentiating between different types of installations, thereby excluding standard PV rooftops from the highest premium and further emphasizing BIPV. Moreover, the French program has special tariffs for educational buildings and hospitals, which receive a higher rate than commercial installations (but still lower than residential systems), recognizing the potential of this market segment.

The incentive structure in France has been successful in promoting BIPV. The country has experienced a 60-fold increase in PV installations between 2006 and 2011, with BIPV accounting for a large portion of this increase. In 2009, BIPV accounted for 59% of annual PV installations in France, considerably higher than in both Germany (1%) and Italy (30%)[13].

Other International Jurisdictions

Among the leaders in PV deployment around the world, Germany and Italy have also made efforts to support the deployment of BIPV. Premiums for BIPV in these jurisdictions were however much lower than in France. Additionally, Germany eliminated its premium in 2009 and there is a possibility that Italy will do the same as part of major changes to the overall renewable energy support program. Consequently, relative to all PV installations, BIPV's share has remained small.

[13] Montoro, D. F., Vanbuggenhout, P. & Ciesielska, Joanna (2010). *BIPV: An overview of the existing products and their fields of application*. SUNRISE & EPIA.

Policy Recommendations

BIPV requires policies tailored to the circumstances surrounding this particular technology rather than broader support aimed at PV. In light of experiences elsewhere, we advise a portfolio of policy options to achieve three general objectives. Since energy falls primarily under provincial jurisdiction in Canada, these policy options are mostly aimed at regional decision-makers. However, the federal government has a facilitative role to play in encouraging policy development surrounding BIPV (through climate-related initiatives for instance), supporting BIPV deployment (through favourable tax treatment for example) and advancing research and demonstration (through tri-council funding agencies).

Objective #1: Remove barriers. The first set of initiatives should aim at eliminating non-financial barriers to BIPV deployment. Changes should consist of modifications to provincial building codes in order to accommodate the integration of BIPV in construction processes. Further efforts should be made to develop standards and regulations specific to BIPV materials as well as to consult with leading construction firms and contractors around removing barriers to the use of BIPV. Training and education programs for architects and engineers, for instance, should be adapted to reflect recent modifications. Together, these efforts would help to eliminate uncertainty related to the use of BIPV in meeting standards, performance criteria and guarantees as well as facilitate the use of BIPV materials by construction professionals. Synergies between BIPV firms and the construction industry should also be explored through funding for new ‘applied’ partnerships.

Objective #2: Incentivize deployment. A second set of policy initiatives should directly target the use of BIPV materials in construction projects. It is important to note that all support should encourage BIPV deployment within buildings that are designed with energy efficiency in mind. In Ontario, BIPV support could be integrated within the FIT program as a separate technology category offering a premium rate. In contrast, other provinces would benefit from implementing incentive rates for BIPV corresponding to peak-demand reductions (for example, the cost of electricity from an additional peaking plant).

Support should also involve the establishment of deployment and generation targets. These targets should be focused around new commercial units and new homes for regulatory simplicity and since these are some of the most promising segments for BIPV. The first target should require new buildings to meet a certain percentage of their annual electricity consumption through BIPV by a certain date. A second target should require a certain proportion of new buildings include BIPV in their design by a particular date. These efforts would gradually promote construction industries to adapt and innovate around BIPV and energy efficiency in general. Commitments should be reviewed annually and upwardly adjusted if appropriate.

The initial capital cost of BIPV in comparison to standard materials is the primary obstacle for this technology at present. As a result, renovation and new construction projects that emphasize energy efficiency and BIPV use should be incentivized through direct subsidies, grants or tax rebates. These grants should be established for early movers and ramped down accordingly.

The rule structure for all support programs should favour private sector participation, notably through financial innovation as has been the case with regular solar panels. For instance, aggregate power purchase agreements and roof leasing programs have proved beneficial for PV deployment – mainly in Europe and the United States – and these arrangements should be explored and promoted within the Canadian BIPV sector.

Objective #3: Advance research and development. BIPV remains at an early stage of development and additional research will continue to unlock efficiency improvements, performance enhancements and novel designs. A third layer of support policies should thus encourage research and development linked to both BIPV and energy efficiency. In particular, funding should focus on demonstration partnerships between government agencies, utilities, universities and leading edge companies in BIPV. Projects like the NSERC Solar Buildings Research Network (SBRN), NSERC Smart Net-Zero Energy Buildings Strategic Research Network (SNEBRN) and the NSERC Photovoltaic Innovation Network should be expanded and replicated. Research conducted through these networks has resulted in a world-first BIPV/thermal demonstration project for a commercial building facade[14]. Efficiency improvements and cost reductions have also followed from this work, with growing interest in extending this research to other buildings (retrofits for example).

[14] Athienitis, A. K., Bambara, J., O'Neill, B. & Faille, J. (2011). "A prototype photovoltaic/thermal system integrated with transpired collector". Solar Energy, 85(1), 139-153.