Economic Impacts of the Composite Recycling Technology Center: A Preliminary Analysis

This preliminary study explores economic impacts expected from development of the Composite Recycling Technology Center in Port Angeles, Washington. Gains in employment, income and business taxes from products created using recycled advanced composite materials are estimated. Other potential benefits include reduced landfill costs, closing the advanced composites carbon loop, and increased competitiveness in the industry.

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Overview

The Composite Recycling Technology Center (CRTC) will bring together infrastructure and technical expertise to transform "pre-preg" composite waste materials into feedstock to produce commercially viable products.[1] The physical proximity of CRTC to a diverse center of advanced composites, Peninsula College's well-established workforce training programs in advanced composites, and a deep water port can create synergies to foster rapid economic growth in a distressed region. At the same time, the innovative approaches used by CRTC to transform advanced composite wastes into feedstock for new product development can be applied to other regions in Washington State, contributing to further economic expansion. Systematic implementation of CRTCs at each stage of the advanced composite life cycle will reduce landfill waste and close part of the carbon cycle.

Conceptualizing an Emergent Sector in the Advanced Composites Industry

Figure 1 traces the flow of advanced composite materials through their life cycle, from production of precursors to disposal of waste. The absence of integrative recycling is one of three challenges to the industry.[2] Creation of CRTC can eliminate the direct flow of discarded materials from primary production to landfill by transforming those materials into feedstock for secondary products. While at present the proposed CRTC envisions product development from pre-preg materials, its design can be extended to recycling cured materials, thus blocking the initial flow of waste towards landfill. Transformation of discarded materials into economically viable feedstock will facilitate development of secondary products that would not be commercially viable using newly manufactured precursors.[3] Creation of CRTCs for cured primary and secondary products, illustrated using dotted circles, can redirect waste flows (dotted lines) from landfill to secondary products. Extension and application of the CRTC vision can close the carbon loop in the advanced composites industry. Ultimately, primary and secondary products move from end users to landfill.

In Figure 1, positive economic impacts, estimated in terms of employment, income and business taxes, on state economic growth are indicated using (+$), while decreases appear as (-$). Production of precursors in Washington increases economic growth, while imported materials cause reductions. CRTC will increase growth, initially in the Port Angeles area, then subsequently to other regions as additional centers are created. Additional gains to economic growth can be derived by decreasing imported materials, from precursors to components used in manufacture, indicated by backward feeding dashed lines. One likely example is "ship hatches," currently imported by the marine sector. Recycled composites can result in production of lower cost substitutes which further stimulate economic growth by reducing imports of materials for primary production.

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[1] The Boeing Corporation has committed to providing discarded pre-preg materials at no charge to CRTC.

[2] *Advanced Composites in Washington State*, Susan St. Germain, Department of Commerce, March, 2014: http://www.kitsapgov.com/hs/olympdev/documents/Department%20of%20Commerce%20Presentation%203-11-14.pdf.

[3] High grade precursor materials have a cost of approximately $7.88 per pound. Recycling eliminates this cost of feedstock by creating lower cost substitutes. The result should be secondary products not economically viable from newly manufactured precursors. *The Composite Industry in Washington*, Commerce Research Services, Department of Commerce, October 2011.

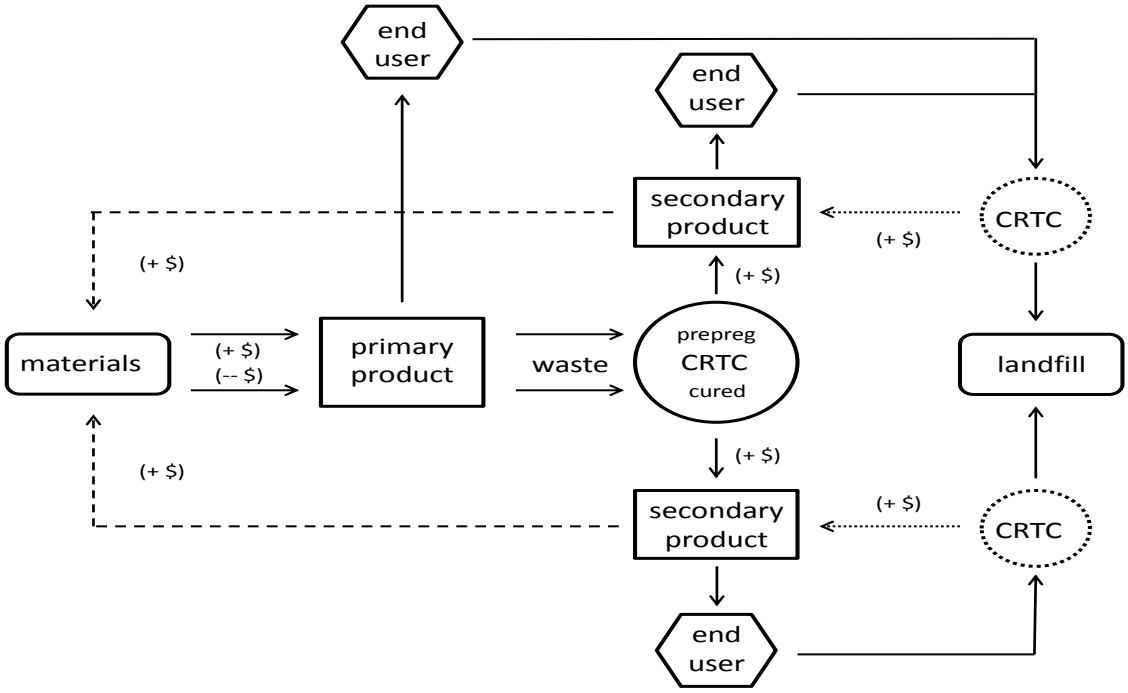

Figure 1: Composite Recycling Technology Center – Economic Development while Closing the Carbon Loop. Solid arrows illustrate the advanced composite materials cycle. In-state materials increase economic growth, indicated by (+$). Imports reduce growth, indicated by (-$). At present, production waste moves directly to disposal. CRTC delays disposal and increases economic growth through secondary production. As proposed, the CRTC will use pre-preg (not cured) materials; by extension and application, equivalent gains can be derived by recycling cured materials. In each case, the redirected waste flow is illustrated using solid arrows, to secondary production, and then end users, increasing growth. Backward feed dashed lines indicate reductions in material use from recycling, with further additions to growth when recycled materials serve as import substitutes. Carbon taxes will increase recycling incentives, waste capture, and product development, further closing the materials cycle. This is illustrated using dotted circles for future CRTCs, additional secondary products, and closing the carbon loop.

Economics Impacts of CRTC in Clallam County: Preliminary Estimates

IMPLAN was used to conduct economic impact analysis, using the Washington 2012 database, with projections through 2014.[4] Members of the Project Team developed scenarios for likely product development from a specified volume of recycled materials, number of employees defined by standard occupation code (SOC), and an estimated annual sales volume.[5] A mean wage for the operation was calculated using SOC wages weighted by relative employment.[6] Together these values were used to

[4] IMPLAN uses expenditure flows to estimate employment and income across economic sectors that map into sectors defined by the North American Industrial Code System. Its use in analyzing advanced composites is problematic as they are materials used in the manufacture of a range of products. Expenditure flows in IMPLAN exist for final products, not necessarily the materials used in production. IMPLAN sector 274, carbon and graphite products, was used in this report, likely understating the aggregate intersectoral linkages for advanced composites.

[5] Geoffrey Wood, MASc, Profile Composites and Dr. Bree Sharratt, Sharratt Research and Consulting Inc.

[6] Washington State Employment Security Department, Occupational Employment & Wage Estimates: https://fortress.wa.gov/esd/employmentdata/reports-publications/occupational-reports/occupations-in-demand

construct direct effects based on employment, income and sales.[7] IMPLAN uses estimated expenditure flows across and within industrial sectors driven by direct effects to compute indirect effects (employment and income) in the supply chain, and induced effects (employment and income) as those employed make expenditures in the local economy. Business taxes include sales taxes, property taxes, and "other" tax categories related to production.

One CRTC product targeted for development is snap form building panels that could be used to construct rural health clinics. Table 1 presents economic impacts for year 1 (startup phase) and year 5 when operations are expected to produce materials for 48 clinics annually using 250,000 pounds of recycled pre-preg.[8] Increases in employment from year 1 to year 5 are driven predominately by the need for skilled composite technicians and production helpers that can be accommodated by the local workforce.[9] By year 5 total direct employment is estimated at 105 with total labor income of $7,041,615 for an average of $67,063; indirect employment at 18.8 with total income of $1,328,369 for an average of $70,658; induced employment is 46.9 with total income of $2,284,201 for an average of $48,704. Business taxes increase from $108,569 in year 1 to $579,435 in year 5.

	Employment		Labor Income		Business Taxes	
Impact Type	**Year 1**	**Year 5**	**Year 1**	**Year 5**	**Year 1**	**Year 5**
Direct Effect	10.25	105	$922,262	$7,041,615		
Indirect Effect	4.5	18.8	$317,185	$1,328,369		
Induced Effect	6.9	46.9	$338,227	$2,284,201		
Total Effect	21.7	170.6	$1,577,674	$10,654,185	$108,569	$579,435

Table 1: Expected economic impacts from panel production using recycled pre-preg.

The values in table 1 should be regarded as low end estimates for at least four reasons. First, the discarded materials from Boeing constitute the first step in capturing advanced composites for recycling. Other sources, some local, will increase the recycled feedstock supply. Second, technological progress will increase the range of feedstock types and potential avenues for application in production. Third, this analysis does not address additional rounds of value added that can result from use and transport of the panels in Washington State. Fourth, expanding the range of advanced composite production in the will likely create further synergies, leading to further rounds of economic development. Such synergies will include, but are not limited to, accelerated workforce training, research and development at nearby institutions and additional rounds of product development as local industry efficiently utilizes the services of CRTC.[10]

[7] Only wages were used as no support information on expected benefits was provided. As a result, induced effects are underestimated.
[8] The total volume of recycled material is 275,000; uses for residuals are not incorporated into this analysis.
[9] Skilled technicians require an Associate's degree. An average wages of $25/hour was assumed. *Composites Wage Survey*, W. Frank Barton, Workforce Alliance of South Central Kansas, February 2011.
[10] Partners include Boeing, Kenmore Air, Intellectual Ventures, Cimtech, PNNL, Pacific Northwest Aerospace Alliance, Profile Composites, Mervin Manufacturing, Angeles Composite Technologies Inc., Westport Shipyards, Craft3, EcycleNW, Port of Port Angeles, City of Port Angeles, Clallam County, Clallam County EDC, Peninsula

Economic Potential of CRTCs across Washington State

Success of the Port Angeles' CRTC will create a model for development of integrative partnerships that can be implemented in other regions of Washington State to recycle advanced composites into new products, further stimulating economic growth. Because such centers do not yet exist, and because one cannot know the kinds of products those centers will develop are unknown, specific occupations with corresponding incomes cannot be determined. We can, however, reasonably assume for this preliminary analysis that, on average, the level of employment with corresponding incomes will be proportionate to the waste recycled. In the previous section, 105 jobs in product manufacture were created by transforming 250,000 pounds of discarded pre-preg materials into a recycled feedstock. Washington State annually discards approximately 2,000,000 pounds of pre-preg advanced composite material.

While it is likely many different secondary products will be derived from recycled materials, the analysis of the previous section is used to estimate economic impacts if the total waste flow is transformed into commercially viable secondary products. Wages by SOC are estimated using Washington State averages, and a weighted mean constructed by relative employment levels.[11] Thus, if 250,000 pounds of recycled waste can support 105 jobs in the production of secondary products, 2,000,000 pounds could produce secondary products valued at $147,456,006, supporting 840 direct jobs in manufacturing with a total income of $57,821,400 for an average of $68,835.[12] These results are presented in Table 2.

Impact Type	Employment	Labor Income	Value Added	Output	Business Taxes
Direct Effect	840	$57,821,400	$100,041,471	$147,456,006	
Indirect Effect	150.3	$10,626,954	$17,637,020	$32,354,692	
Induced Effect	383.2	$18,679,863	$32,999,388	$54,040,496	
Total Effect	1,373.5	$87,128,217	$150,677,879	$233,851,195	$4,736,517

Table 2: Expected economic impacts disseminating CTRCs state-wide, including Clallam County.

This preliminary analysis indicates that spurring development of an industry that can recycle pre-preg advanced composites can create $150,677,879 in value added from a gross output of $233,851,195, generating business taxes of $4,736,517 in the fifth year of operation, a value likely to increase with growth in the advanced composite industry. For each job created through advanced composites recycling, 0.6 additional jobs are created, either in the supply chain (indirect effects), with an average income of $70,705, or elsewhere in the region with an average income of $63,435.[13] These economic impacts are expected from recycling pre-preg materials. Extension and application of the approaches

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College, UW, WSU, UCLA, University of Alabama-Birmingham, Center of Excellence in Aerospace and Advanced Materials Manufacturing, Pacific NW Center of Excellence for Clean Energy, NW Center of Excellence for Marine Manufacturing & Technology, Olympic College, Everett Community College.

[11] In the previous section, wages by SOC were estimated for Clallam County.

[12] For reasons presented in the previous section, these are likely conservative estimates.

[13] Indirect effects are small because we assume an end of line production process. That is, waste moves directly into a secondary final product, not into intermediate products. If the later occurs, multipliers will be larger.

envisioned in CRTC to cured materials could further increase those positive impacts. Lines of capture and redirection to new secondary products are illustrated in Figure 1.

CRTC, Economic Development, and the Carbon Loop: Opportunities for Investment

Advanced composites are projected to increase five to fifteen percent over the next five years.[14] Integration of recycling into the industry can play a pivotal role in reducing landfill and other potential ecological costs. CRTC can play that role and, simultaneously, help increase the growth trajectory through development of recycled feedstock that stimulates development of a wide range of secondary products. Thus, economic growth with CRTCs will be greater than would otherwise occur. Recycling of materials can reduce imports into the advanced composites industry, further stimulating economic growth. More subtle, and implicit in the analysis of this report, is that the diversion of discarded materials towards CRTCs will reduce production costs in the advanced composites sector, increase profit margins, and improve competition positions. Lower production costs, a wider range of finished products combined with Washington State's access to deep water ports can help leverage increased exports to the Pacific Rim and challenge Japan's dominance of advanced composite exports. Lastly, the economic and ecological benefits described in this preliminary report can be realized, and perhaps increased, should the State move forward with use of a carbon tax to address climate change. Creation of CRTC regional nodes throughout the industry, with discarded material capture, processing and product development, would be further incentivized by such a tax. The existence of CRTCs can play a pre-emptive role in reducing or eliminating adverse economic impacts from a carbon tax. To the extent Washington is ready, and other states are not, will only reinforce competitive advantages.

[14] *Advanced Composites in Washington State*, previously cited.

Addendum – First Look at the Economic Impacts of Cured Recycling

	Cured Recycling: 500,000 Pounds		Secondary Product Manufacturing		Combined Recycling and Manufacture	
Effect	Employment	Income	Employment	Income	Employment	Income
Direct	20	$1,341,260	105	$7,041,615	125	$8,382,875
Indirect	3.1	$216,206	18.8	$1,328,369	21.9	$1,544,575
Induced	8.7	$425,044	46.9	$10,654,185	55.6	$11,079,229
Total	31.8	$1,982,510	170.6	$10,654,185	202.4	$12,636,695
Business Taxes	$103,085		$584,469		$687,554	
	Cured Recycling: 2,000,000 Pounds		Secondary Product Manufacturing		Combined Recycling and Manufacture	
Effect	Employment	Income	Employment	Income	Employment	Income
Direct	80	$5,365,040	420	$28,166,460	500	$33,531,500
Indirect	12.2	$846,824	420	$5,313,477	432.2	$6,160,301
Induced	34.9	$1,700,177	187.4	$9,136,803	222.3	$10,836,980
Total	127.1	$7,930,041	682.6	$42,616,740	809.7	$50,546,781
Business Taxes	$412,383		$2,337,875		$2,750,258	

Preliminary look at potential economic impacts derived from using Adherent Technology systems to recycle cured composite wastes and produce secondary finished products. Representatives of the Port of Port Angeles have initiated discussion centered on creation of a cured advanced composites recycling center in Port Angeles, an investment of approximately $10,000,000. The table presents two scales of recycling: 500,000 and 2,000,000 pounds of material. Under both scenarios, approximately half the recycled weight takes the form of recycled carbon fiber, to which resin is reapplied to create pre-preg materials (correspondence, Dr. Bree Sharratt). Thus, 500,000 pounds of recycled cured material can create an equal weight of pre-preg material. Employment numbers for recycling are approximate (correspondence, Port Commissioner McAleer). Income estimates followed the analysis of Daniel Underwood, *Economic Impacts of the Composite Recycling Technology Center: A Preliminary Analysis*, October 3, 2014 Economic impacts from secondary product manufacturing assumed one-fourth of the recycled materials would be used locally, and used the employment values for panel production provided by Geoff Wood and Dr. Bree Sharratt.

The assumptions used in the above scenarios have not been tested. Thus, the values are “approximates.” They are useful to help the reader better understand the economic development opportunities recycling advance composite can play as the carbon loop is closed. See Figure 1, See Daniel Underwood, cited above. All results generated using IMPLAN, sector 274, composites and graphite production.