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# Lignin-Based Carbon Fiber:

## A Case for Sustainable Advanced Technology Manufacturing in Michigan's Upper Peninsula

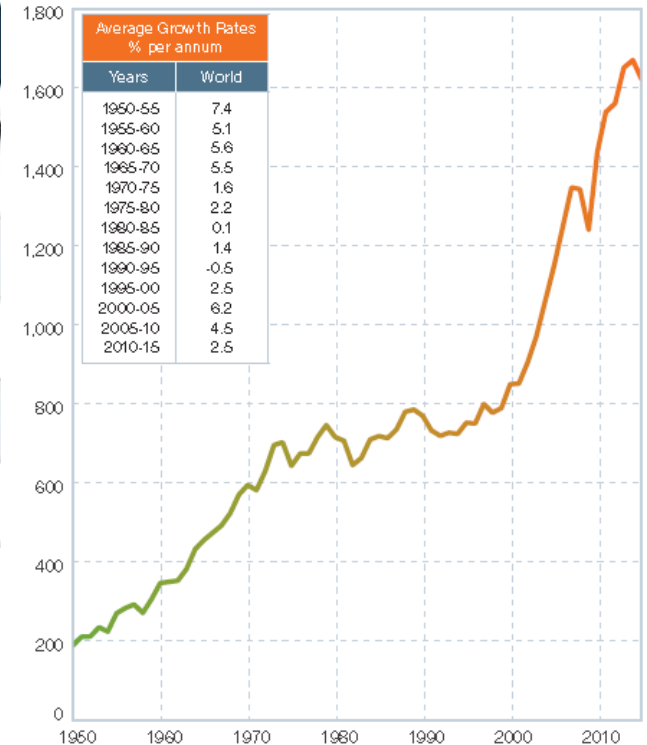
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# Carbon Fiber – The Steel of the Next Century?

(in terms of importance to advancements in structures)

Carbon fiber demand and supply, metric tonnes (MT)			
	Carbon fiber demand	Carbon fiber supply (nameplate)	Carbon fiber supply (actual)*
2010	48,370	79,650	47,790
2015	82,400	143,595	93,171
2020 (est.)	150,200	180,600	129,965

*\*Actual output is less than nameplate, due to capacity knockdown.*



Anticipated CAGR in CF demand of 9.21% through 2024.  
Source: Composites Forecasts and Consulting LLC article in CompositesWorld magazine 3/17/16.

## **Dwindling Population, Advances in Manufacturing Technology, & Globalism Threaten Future of Upper Peninsula Way of Life.**

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- Between 1995 & 2011, public school enrollment decreased 27% in U.P. Schools.
- Population decreased by 4%.
- Average Age increased from 42 to 47 years old.
- Employment has historically been natural resource-based.
  - Mining – mines played out, environmental concerns
  - Logging – increases in productivity
  - Fishing – treaties that prevent non-native fishing
  - Farming – increases in productivity
- Reductions in print media threaten major industry: paper-making.

## Case for Lignin-Based CF in U.P.

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- Close to Source (pulp & paper mills – provides them added revenue.
- Transportation & other utilities needed are readily available.
- Area is in desperate need of sustainable industry.
- Massive operations are not needed to make a significant impact.



# Largest Employers in U.P. Counties - 2010

(Compiled by the Northern Michigan University Center for Rural Community and Economic Development )

DELTA	1200 NEWPAGE	SCHOOLCRAFT	227 SMH
	1000 CHIP-IN CASINO	ONTONAGON	375 ASPIRUS KEWEENAW
	750 ST. FRANCIS	MENOMINEE	800 BAMC
	400 EMP	MARQUETTE	2831 MGH
	KINROSS		1567 CCI
CHIPPEWA	1191 PRISON		620 EMPIRE
	BAY MILLS		999 NMU
	753 RESORT	MACKINAC	N/D
	WAR MEMORIAL	LUCE	399 SOM
	664 HOSPITAL	KEWEENAW	N/D
BARAGA	310 KBIC		NORTHSTAR HEALTH
	MI DEPT. OF	IRON	180 SYSTEM
	300 CORRECTIONS	HOUGHTON	1450 MTU
	BARAGA MEMORIAL		PORTAGE
	202 HOSPITAL		579 HEALTH
	170 TEREX		436 ASPIRUS KEWEENAW
ALGER	250 NEENAH PAPER	GOGEBI	DANCING EAGLES
	MI DEPT. OF	C	400 RESORT
	200 CORRECTIONS	DICKINSON	615 DHCS
	TIMBER		475 VERSO
	142 PRODUCTS		NORTHERN STAR
	CHRISTMAS KEWADIN		425 INDUSTRIES
	120 CASINO		420 VA
			GREDE
			392 FOUNDRIES