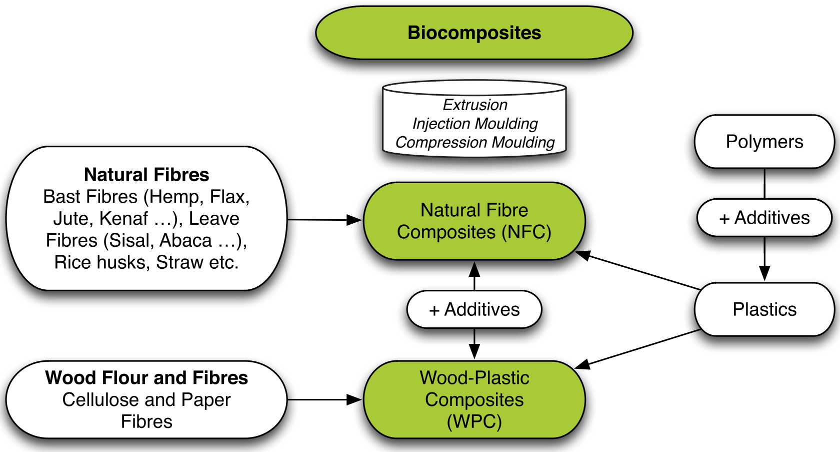
Short Version

WPC/NFC Market Study 2014-10 (Update 2015-06)

Wood-Plastic Composites (WPC) and Natural Fibre Composites (NFC):

European and Global Markets 2012 and Future Trends in Automotive and Construction



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Biocomposites: 352,000 t of wood and Natural Fibre Composites produced in the European Union in 2012 – Executive summary

Authors: Michael Carus, Dr. Asta Eder

The most important application sectors for biocomposites are construction (decking, siding and fencing) and automotive interior parts. Between 10 and 15% of the total European composite market is covered by Wood-Plastic Composites (WPC) and Natural Fibre Composites (NFC). The study was conducted by the nova-Institute (Germany) in cooperation with Asta Eder Composites Consulting (Austria/Finland).

This market report gives the first comprehensive and detailed picture of the use and amount of wood and natural fibre reinforced composites in the European bio-based economy. The analysis covers both Natural Fibre Composites and Wood-Plastic Composites in extrusion, injection and compression moulding in different sectors and for different applications.

To establish a reliable basic dataset, the study draws on a survey conducted in 2013 among the WPC and NFC industry, producers and customers that belong to Asta Eder Composites Consulting's and the nova-Institute's comprehensive networks. The survey included company visits, personal and telephone interviews, as well as an email questionnaire.

Production of Biocomposites (WPC and NFC) in the European Union 2012 (in tonnes)

Wood-Plastic Composites	**260,000**
Decking	174,000
Automotive	60,000
Siding and Fencing	16,000
Technical Applications	5,000
Furniture	2,500
Consumer goods	2,500
Natural Fibre Composites	**92,000**
Automotive	90,000
Others	2,000
Total Volume Biocomposites (WPC and NFC)	**352,000**
Share	**15 %**
Composite Production in European Union, total volume (Glass, Carbon, WPC and NFC)	2.4 Million

Table I: Production of biocomposites (WPC and NFC) in the European Union in 2012 (in tonnes) (nova 2014)

The rate of return was exceptionally high, especially for the WPC part of the study, with companies responsible for over 50% of extruded volume taking part in the survey. This means that the study covers roughly 65 European WPC extruding companies in 21 countries. In addition, more than 50 European companies using injection moulding, compression moulding and other processing technologies were included in the survey, as well as producers of WPC and NFC granulates.

Total production of biocomposites

Table I summarises the results of the survey, showing all Wood-Plastic Composites and Natural Fibre Composites produced in the European Union, including all sectors, applications and processing technologies.

Decking and automotive are the most important application sectors for WPC, followed by siding and fencing. Only the automotive sector is relevant for Natural Fibre Composites (NFC) today. The share of WPC and NFC in the total composite market – including glass, carbon, wood and Natural Fibre Composites – is already an impressive 15%. Even higher shares are to be expected in the future: NFC are starting to enter other markets than just the automotive industry. WPC granulates for injection moulding are now produced and offered by global players and are becoming more attractive for clients that manufacture consumer goods, automotive and technical parts.

With increasing polymer prices and expected incentives for bio-based products (the “bio-based economy” is one of the lead markets in Europe) this trend will go from strength to strength, resulting in two-digit growth and increasing market shares over the coming decade.

Wood-Plastic Composites – Decking still dominant, but technical applications and consumer goods rising

The total volume of WPC production in Europe was 260,000 tonnes in 2012 (plus 92,000 tonnes of Natural Fibre Composites for the automotive industry, see Table I). The level of market penetration of bio-based composites varies between regions and from one application field to the next. Germany leads the way in terms of the number of actors and production figures. 45% (85,000 tonnes) of European WPC production for decking, fencing and other construction applications (190,000 tonnes) was extruded by 20 German companies.

The typical production process in Europe is extrusion of a decking profile based on a PVC or PE matrix followed by PP. Increasing market penetration by WPC has meant that WPC volumes have risen strongly and Europe is now a mature WPC market. This study predicts growth, especially in the German-speaking world, on the back of a recovery in construction, particularly renovation, and a further increase in the WPC share of the highly competitive decking market. Also, variations of WPC decking models such as capped embossed solid profiles or garden fencing are on the rise across Europe.

The development of the distribution across applications points to a state of affairs in which WPC is increasingly used for applications beyond the traditional ones like decking or automotive parts. For example, WPC is increasingly used to produce furniture, technical parts, consumer goods and household electronics, using injection moulding and other non-extrusion processes. Also, new production methods are being developed for the extrusion of broad WPC boards.

Figure I shows the various application fields of WPC produced in Europe. The decking market leads the way with 67% (mainly extrusion), followed by automotive interior parts with 23% (mainly compression moulding and sheet extrusion as well as thermoforming). Although they are still small, siding and fencing, along with technical applications (mainly extrusion), consumer goods and furniture (mainly injection moulding), are showing the highest percentage increases.

In the face of rising plastic prices, WPC granulates are getting more and more attractive for injection moulding, and increasingly feature in European granulate suppliers' product ranges. Three big paper companies released cellulose-based PP granulates for injection moulding between 2012 and 2013. They use a PP matrix with cellulose and have fibre shares of between 20 and 50% for new and interesting applications such as furniture, consumer goods and automotive parts.

The report also gives an overview of the latest market developments in North-America, Asia and Russia, and provides an overview of, and a forecast for, the global WPC market. Worldwide WPC production will rise from 2.43 million tonnes in 2012 to 3.83 million tonnes in 2015. Although North America is still the world's leading production region with 1.1 million tonnes, ahead of China (900,000 t) and Europe (260,000 t), it is expected that China (with 1.8 million t by then) will have overtaken North America (1.4 million t) by 2015. European production will grow by around 10% per year and reach 350,000 tonnes in 2015.

The share of WPC decking in the North American decking market is once more on the up, after a period of housing crises and WPC quality problems that led to a shakeout of the top WPC producers.

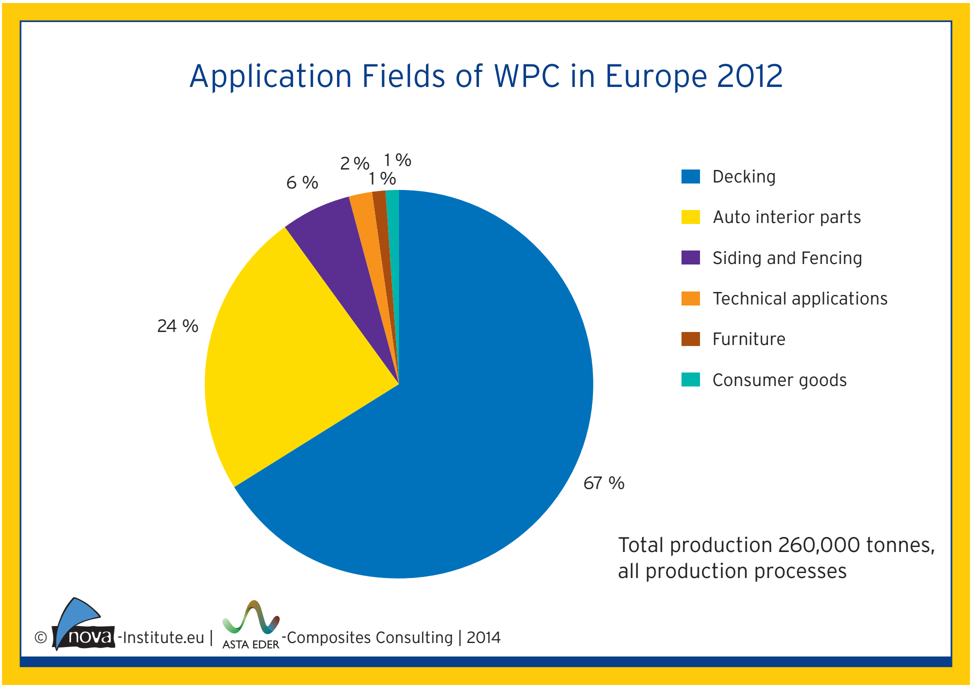

Figure I: Application fields of WPC in Europe in 2012 (Total production 260.000 tonnes, all production processes) (nova 2014)

In China, decking also has a larger market share than other WPC applications, mainly due to strong exports, although the domestic market has developed rapidly in recent times. China also has the largest window and door market in the world. Hence companies have lately started to produce commercial window frames using WPC, with approximately 40% wood fibre as a substitute for PVC in combination with aluminium. China produces a large variety of WPC for indoor applications. Another successful product is an extruded WPC door that is already produced by 30 companies.

WPC and NFC in the automotive industry

Interior parts for the automotive industry is by far the most dominant use of Natural Fibre Composites – other sectors such as consumer goods are still at a very early stage. In the automotive sector, Natural Fibre Composites have a clear focus on interior trims for high-value doors and dashboards. Wood-Plastic Composites are mainly used for rear shelves and trims for trunks and spare wheels, as well as in interior trims for doors.

Figure II shows the total volume of 80,000 tonnes of different wood and natural fibres used in the 150,000 tonnes of composites for passenger cars and lorries that were produced in Europe in 2012 (90,000 tonnes of Natural Fibre Composites and 60,000 tonnes of WPC). Recycled cotton fibre composites are mainly used for the driver cabins of lorries.

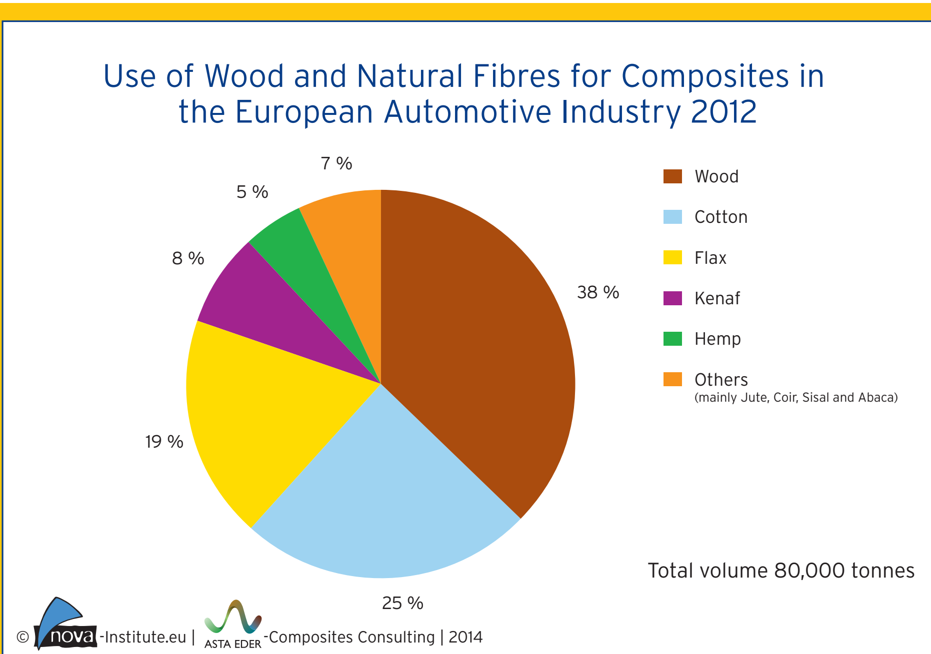

Figure II: Use of wood and natural fibres for composites in the European automotive industry in 2012, including cotton and wood (total volume: 80,000 tonnes). "Others" are mainly jute, coir, sisal and abaca (nova 2014)

The highest market shares are for wood (of European origin), recycled cotton (from the world market) and flax fibres (of European origin). The shares of kenaf (from Asia) and hemp fibres (European origin) show the largest increases in percentage terms since the last survey for the year 2005.

Process-wise, compression moulding of wood and Natural Fibre Composites are an established and proven technique for the production of extensive, lightweight and high-class interior parts for mid-range and luxury cars. The advantages (lightweight construction, crash behaviour, deformation resistance, lamination ability and, depending on the overall concept, price) and disadvantages (limited shape and design forming, scraps, cost disadvantages in case of high part integration in construction parts) are well known. Process optimisations are in progress in order to reduce certain problems such as scraps and to recycle wastage.

Since 2009, new improved compression-moulded parts have shown impressive weight-reduction characteristics. This goes some way to explaining the growing interest in new car models. Using the newest technology, it is now possible to get area weight down to 1,500 g/m^2 (with thermoplastics) or even 1,000 g/m^2 (with thermosets), which are outstanding properties when compared to pure plastics or glass fibre composites.

Still small in volume but also strong in innovation: PP and cellulose-based granulates for injected-moulded parts were recently introduced onto the automotive market by big paper companies in Europe and the USA.

15.7 million passenger cars were produced in the EU in 2011, and an additional 2 million other motor vehicles (incl. trucks, transporters, motor bikes, etc.) were manufactured. Considering that 30,000 tonnes of natural fibres and another 30,000 tonnes of wood fibres were used in 15.7 million passenger cars, on average every passenger car in Europe contains 1.9 kg of natural fibres respectively 1.9 kg of wood fibres. Since the German automotive industry is the most important consumer of natural fibre parts within the European automotive sector and since natural fibres are more used in middle- and high-class cars, the figures of 1.9 kg for the European average and 3.6 kg for the German average match well.

From a technical point of view, much higher volumes of WPC and NFC are possible. Vehicles have been successfully produced in series for years with considerably larger amounts: 20 kg of natural and wood fibres. Market developments also depend on the political framework: any incentives for the use of natural and wood fibres in the European automotive industry could help to extend the existing volumes of 30,000 t/year each for natural and wood fibres. Such a vision could lead to an increase by a factor of up to five, which would represent 150,000 t per year and fibre type; the technologies are ready to use. Biocomposites have great potential!

Outlook for WPC and NFC production in the EU until 2020

As just discussed, the production and use of 150,000 tonnes biocomposites (using 80,000 tonnes of wood and natural fibres) in the automotive sector in 2012 could expand to over 600,000 tonnes of biocomposites in 2020, using 150,000 tonnes of wood and natural fibres each along with some recycled cotton. Yet this fast development will not take place if there are no major political incentives to increase the bio-based share of the materials used in cars. Without incentives we forecast that production will only increase to 200,000 tonnes.

Huge percentage increases can also be expected for WPC granulates used in injection moulding for all kind of technical and consumer goods. With improved technical properties, lower prices and bigger suppliers capable of supporting their customers, we forecast a growth from the tiny amount of 10,000 tonnes in 2012 to 100,000 tonnes by 2020. Additional incentives might at least double the production. For NFC granulates we foresee only niche markets with specific demand, reaching 10% of the WPC granulate market or 10,000 t in 2020.

Table II also includes the amounts of traded granulates for extrusion and injection moulding. In extrusion the share of direct extrusion is high and therefore the share of traded granulates is low. In injection moulding most is processed with granulates.

Extruded WPC is now well established as a material for decking, fencing and facade elements. Its market share is still growing and should reach and surpass the level of tropical wood in most of the European countries by 2020. About 190,000 tonnes of WPC were produced in Europe for the construction sector in 2012 – and this will be surely increase to 400,000 t in 2020. Unlike other sectors, political incentives will have only a small impact, because WPC are positioned against other bio-based materials and not, as in automotive or consumer goods, pitched against petrochemical plastics. Nevertheless, the whole framework of bio-based economy including green material databases will also give impetus to WPC decking.

Biocomposites	Production in 2012	Forecast production in 2020 (without incentives for bio-based products)	Forecast production in 2020 (with strong incentives for bio-based products)
WPC			
Construction, extrusion	190,000 t	400,000 t	450,000 t
Automotive, compression moulding & extrusion/thermoforming	60,000 t	80,000 t	300,000 t
Technical applications, furniture and consumer goods, mainly injection moulding	15,000 t	100,000 t	> 200,000 t
Traded granulates for extrusion and injection moulding	*40,000 t*	*200,000 t*	*> 300,000 t*
NFC			
Automotive, compression moulding	90,000 t	120,000 t	350,000 t
Granulates, injection moulding	2,000 t	10,000 t	> 20,000 t

Table II: Production of biocomposites (WPC and NFC) in the European Union in 2012 and forecast 2020 (in tonnes) (nova 2015)

The authors of the study

Dipl.-Phys. Michael Carus – *nova-Institute (Germany)* physicist, founder and managing director of the nova-Institute, is working for over 15 years in the field of Bio-based Economy. This includes biomass feedstock, processes, bio-based chemistry, plastics, fibres and composites. The focus of his work are market analysis, techno-economic and ecological evaluation as well as the political and economic framework for bio-based processes and applications ("level playing field for industrial material use"). Since 2005, Michael Carus is managing director of the European Industrial Hemp Association (EIHA).
nova-Institute is a private and independent institute, founded in 1994; nova offers research and consultancy with a focus on bio-based and CO_2-based economy in the fields of feedstock, techno-economic evaluation, markets, LCA, dissemination, B2B communication and policy. Today, nova-Institute has 25 employees and an annual turnover of more than 2 million €.

Dr. rer. nat. Asta Eder – *nova-Institute (Germany)* is one of the leading market experts on biocomposites, especially on Wood-Plastic Composites. Dr. Eder did her PhD-work on market opportunities of innovative wood composites (WPC and Thermowood) in the German speaking area. She has been conducting market research and consulting for the development of new bio-based composites and their applications for the last 15 years.
For several years, she worked as a consultant with her own company "Asta Eder Composites Consulting" in Vienna, Austria. The focus was on the WPC market, including product development and launching, marketing and sales. Since 2014, Asta Eder has been working as full-time staff at nova-Institute in the department "Technology & Markets". Here, her focal points are biocomposites, standards and labelling of bio-based products.

M.A. Pol. Lara Dammer – *nova-Institute (Germany)* studied Political Science with a focus on sustainable development at Bonn University. She is a staff scientist in the field of policy and strategy at nova-Institute. Her main focus is on framework conditions for the material use of renewable resources, national and international resource and environmental policies as well as communication and dissemination. She is active in analysing hurdles and enablers for a bio-based economy in Germany and the EU. As project manager she is currently working on a master plan for the development of the national kenaf industry with the government of Malaysia.

Dr. rer. nat. Hans Korte – *PHK Polymertechnik GmbH (Germany)* studied Forestry at Hamburg University and gained a PhD in Biochemistry before taking up a post with an international chemical company, for whom he carried out R&D work on cellulose, was Head of Technical Marketing of Director of Sales of geoplastics.
Since 2000 he has worked in Wismar as a freelance consultant on process, material and product development for wood, fibres and composites. He initiates and coordinates national and international research projects, conducts market surveys and writes expert reports. In 2002 he set up, and has since run, PHK Polymertechnik GmbH in Wismar, a company that develops and markets new materials such as Rotowood, WPC for rotation sintering, and Nerolit, a hydrophobic, durable and thermally stable filling material for plastic composites.

Dipl.-Wirtsch.-Ing. Lena Scholz – *nova-Institute (Germany)* is an industrial engineer with a focus on bio-based materials, especially bioplastics and bio-composites. Her expertise includes detailed knowledge of the global bioplastics market and she is one of the authors of the Market Study on Bio-based Polymers. Together with Michael Carus she has observing status in the CEN Committee for bio-based products representing the European Industrial Hemp Association. Since 2014, Lena Scholz is project manager at Tecnaro GmbH.

Dipl.-Umweltwiss. Roland Essel – *nova-Institute (Germany)* studied environmental sciences at the Universities of Trier, Edinburgh and Karlsruhe and graduated from the University of Trier in 2010 with a thesis about the eco-efficiency of economic sectors in Europe. He started his career as a consultant for Taurus Eco Consulting GmbH as well as a research assistant at the chair of environmental accounting at the University of Technology in Dresden. Since May 2011 Roland Essel is project manager at the nova-Institute GmbH and responsible for ecological evaluation and environmental resource management. His field of expertise covers life cycle assessment (LCA), system analysis and modelling (simulation & scenario analysis) of environmental impacts.

M.Sc. agr. econ. Elke Breitmayer – *nova-Institute (Germany)* studied Agricultural Economics at the University of Hohenheim, Germany with a focus on resource economics and rural development.
In 2010 she was awarded a PhD scholarship from the DFG (German Research Foundation). She worked on the assessment of environmental impacts in intensive agricultural systems in China and as a scientific assistant at the Food Security Center at the University of Hohenheim. She joined the nova-Institute in 2013.

Dipl.-Ing. Martha Barth – *nova-Institute (Germany)* studied at the Technical University of Vienna and at the Montanuniversität Leoben (Austria) and graduated in „Industrial Environmental Protection, Waste Disposal Technology and Recycling“. For several years, she worked at an engineering office and was in charge of construction supervision regarding chemical and environmental subjects as well as the planning and monitoring of the research and remediation of contaminated sites in Austria. With her comprehensive knowledge of waste, supply and disposal management, Martha Barth supports the nova team in the field sustainability assessment of innovative products. Life Cycle Assessment and the implementation of sustainability certifications of bio-based products are also part of her work.

The market study **"Wood-Plastic Composites (WPC) and Natural Fibre Composites (NFC): European and Global Markets 2012 and Future Trends in Automotive and Construction"** gives the first comprehensive and detailed picture of the use and amount of wood and natural fibre reinforced composites in the European bio-based economy.

The full report covers the following subjects on 90 pages (updated chapters, figures and tables highlighted in red):

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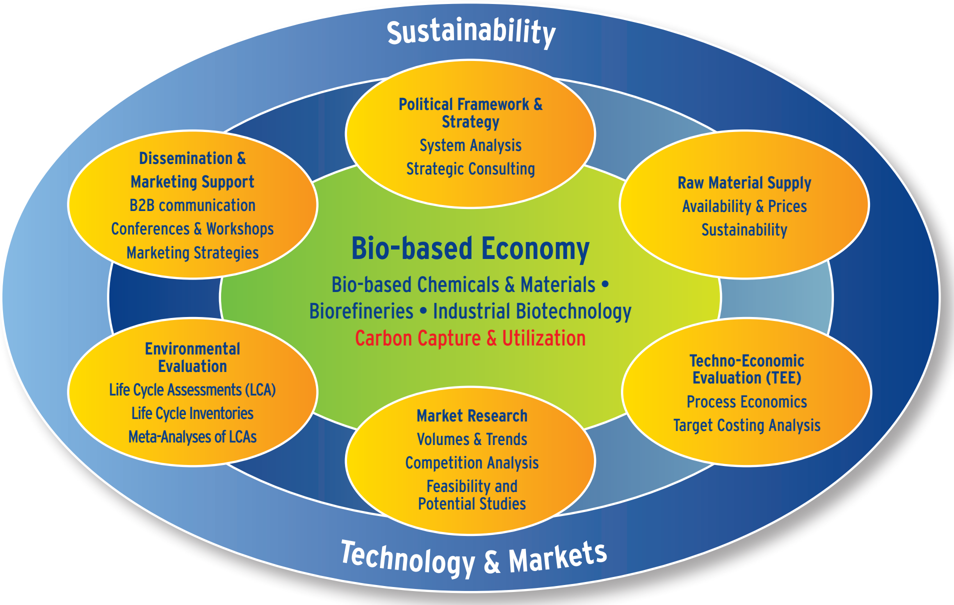

nova-Institute

The nova-Institut GmbH was founded as a private and independent institute in 1994. It is located in the Chemical Park Knapsack in Huerth, which lies at the heart of the chemical industry around Cologne (Germany).
For the last two decades, nova-Institute has been globally active in feedstock supply, techno-economic and environmental evaluation, market research, dissemination, project management and policy for a sustainable bio-based economy.

Key questions regarding nova activities

What are the most promising concepts and applications for Industrial biotechnology, biorefineries and bio-based products? What are the challenges for a post petroleum age – the Third Industrial Revolution?

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