Renewable Energy as a Market Opportunity for Chemicals in China

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There is limited need to explain the importance of renewable energy for China or indeed the whole world. Fossils fuels are both limited in their supply and contribute heavily to global warming. China as the world`s largest emitter of carbon dioxide with a 27% share of global emissions in 2017 holds a huge responsibility in this respect. Nuclear power has a better record with regard to global warming, but also depends on a limited supply of non-renewable materials and poses its own safety risks. Clearly, renewable energy is and will continue to be on the rise. China is moving in the right direction and has already increased the proportion of electricity produced from renewables from 18% in 2008 to about 26% in 2017.

China`s government has taken notice, giving strong political support to the development of renewable energy. In fact, a recent report by the influential Global Commission on the Geopolitics of Energy Transformation states that "no country has put itself in a better position to become the world's renewable energy superpower than China". The report also points out that China is now the world's largest producer, exporter and installer of solar panels and wind turbines as well as the leader in patents in this area. And according to the International Energy Agency, China will account for over 40% of new global renewable capacity from 2018 to 2023.

Several factors lead to China being a leader in this area. The country is a huge importer of fossil fuels due to limited own oil resources, with a 70% dependency on oil imports and a 45% dependency on natural gas imports. There is also pressure on the government to limit the dependency on coal for environmental reasons. Renewable energy tends to be created locally, thus not requiring imports. It is also a new frontier giving China a chance to gain technology leadership and to thus avoid the middle-income trap. Therefore, it is not surprising that the NDRC in 2018 wrote a draft policy increasing the renewable energy target from 20% to 35% in 2030. China`s determination to increase the share of renewable energy is also reflected in its world-leading investment of US$126.6 billion in 2017.

There are many sources of renewable energy, including the well-established hydroelectric power as well as some which so far are only of limited importance, such as tide, geothermal, and solar thermal energy. However, solar power and wind energy are currently the sources showing by far the biggest potential for growth and will therefore be the focus of this paper.

Both solar and wind are relatively recent technologies, at least with regard to the production of electricity (in China, windmills have been used for more than 800 years already, primarily to lift water). This means they are immature, still very likely allowing rapid improvements in technology type, efficiency and cost. These improvements are founded on new materials and thus offer substantial opportunities for chemical companies developing superior alternatives to existing solutions.

Depending on the specific function of each material in generating solar or wind power, different characteristics of these materials need to be improved. However, a number of

properties offer improvement potential for all materials:

- The cost of materials should obviously be low
- Production processes and the materials themselves should be as environmentally friendly as possible
- The materials should be designed with a future recycling in mind as all devices will eventually need to be retired and dismantled

Apart from these general requirements, specific improvements are desired for individual materials and components. Tab. 1 gives some examples.

For wind energy, the polymers employed for the rotor blades of the turbines play a vital part in capturing the wind energy. While several polymers and polymer composites have already been utilized, there is still much to improve in areas such as light-weighting and tensile strength. In addition, requirements may be tightening as the size of the rotor blades increases. These requirements will get even tougher as the utilization of wind spreads, as this means the conditions under which wind turbines operate will become tougher. For example, the offshore generation of wind energy generated will require materials that are more resistant to corrosion and mechanical stress, as the salt water conditions are highly corrosive, wind strengths are higher and the cost of repairing damaged parts of wind turbines also increases.

For solar energy, the focus is on improving the panels themselves, both with regard to the manufacturing processes and the conversion rates of the cells. Process improvement may particularly focus on reducing or controlling the use of the toxic chemicals utilized therein. Similar to wind energy, for solar power to be utilized more widely, expansion into areas with high temperature differences and strong winds (e.g., deserts, with Northwestern provinces Gansu and Qinghai as current main test grounds) will also impose tighter requirements on the materials employed. At the same time, requirements regarding the environmental friendliness of production processes and for recyclability of used components will increase as well.

Both wind energy and solar energy have the disadvantage of not being as consistently and reliably available as fossil fuels or nuclear power. This opens up another market for producers of chemical materials, that for energy storage. Of course, with the rise of electric vehicles this is already an area of substantial research. However, the storage of large amounts of energy from wind or solar without the need for mobility of the storage

Type of renewable	Component	Function	Chemicals (examples)	Properties to be improved (examples)
Wind	Rotor blades	Capturing the wind energy	Glass-fibre reinforced plastics, carbon-fibre reinforced plastics	• Weight reduction • Increased strength
Wind	Coatings	Corrosion protection	Epoxy coating system, fluorocoatings	• Increased durability • Low dirt-pickup • Ease of application
Wind	Adhesives	Adhesion between different parts	Acrylic, epoxy, urethane and vinyl ester/polyester resins	• Durability • Adhesion
Wind	Lubricants	Lubrication	Lube oils and lube additives	• Better prevention of micropitting and etching • Longer intervals
Solar	Silicon raw materials	Photovoltaic element	Silicon, various metals and metal oxides	• Conversion rate
Solar	Silicon alternatives	Photovoltaic element	Perovskit, silicon nanoparticles (experimental stage)	• Conversion rate • Avoidance of heatup
Solar	Element protection	Protection	Polymers, e.g., polyamide	• Durability
Solar	(Silicon processing)	Silicon processing	Etchants, e.g., NaCN	• Environmental friendliness

may favor other solutions, e.g., batteries composed of different materials or the storage of energy as hydrogen created by electrolysis of water. Examples for ongoing research in this area include the use of silicon in lithium-ion batteries instead of graphite, thus potentially boosting the storage capacity by a factor of 11 (though hindered by obstacles such as the huge expansion of the silicon anode), or the work on durable core-shell nanostructured electrocatalyst replacing the anode in water electrolysis, replacing less stable and more expensive ruthenium and iridium oxides.

As Tab. 1 shows, the number of specialty chemical segments that may serve as suppliers to wind and solar energy is quite large. While some are quite obvious, such as specialty polymers, coatings and adhesives for wind power and electronic chemicals for solar power, some are less so, such as lubricants for wind power. Some segments may not even have a high awareness of renewable energy being a relevant and fast-growing customer segment. So, the first step in supplying this market is establishing internal and subsequently external awareness of the company`s offerings to the renewable energy segment. Several companies have already taken steps in this direction:

- Afton has published an extensive presentation on the specifics of lubrication of wind turbines, showing a detailed understanding of the issues involved as well as the open challenges
- AkzoNobel presents the company as "single source supplier of coatings for wind turbines - from tip to toe"
- ASK Chemicals is developing system solutions especially for large-scale cast parts for wind turbines
- BASF bundles some of their products for the solar industry under the title "Chemicals for the solar energy industry", and has a dedicated Manager Solar Business
- Evonik offers products and components for solar cell production using the claim "We turn solar power into next generation energy"
- Hexion claims to have been "helping the first fiber-reinforced rotor blades harness the power of wind". The focus today is to improve the company`s epoxy composite systems in order to make blades bigger, lighter, stronger, more durable, and more cost efficient.

A second step is to develop products and materials that specifically focus on the requirements of the renewables segment for improved properties (see examples shown in Tab. 1). Of course, this will need to start with developing a much deeper understanding of the challenges faced by the devices utilized to generate solar and wind power. Subsequently, solutions for these challenges need to be developed. This will not always be straightforward. On the positive side, makers of solar and wind power equipment themselves will only have limited materials knowledge, putting the supplier of chemical materials in the potentially lucrative role of solutions provider and also allowing such supplier to leverage problem solving knowledge from other applications of their products for the renewables segment.

The cost of the chemicals typically only accounts for a small share of the investment in large renewable projects while potentially making huge differences in the revenue stream derived from them (e.g., by increasing the reliability and durability of energy generation, thus increasing revenues and decreasing costly repairs). To give an example, according to Peter Plagemann from the reputable German Fraunhofer institute, the maintenance and repair costs of offshore wind turbines over the years add up to be a hundred times the cost of the new turbine itself.

This should allow chemicals producers supplying this segment to derive substantial economic benefit from their products, e.g., via value pricing. It should also favor those companies focusing on innovation and having strong R&D capabilities as the immaturity of the renewables technology allows for innovative solutions and developing truly superior products – a potential that in many mature customer segments is already relatively small. That – in combination with the high growth in demand for renewable energy – provides a good reason for specialty chemical companies to increase their focus on this segment. This will require both segment-specific marketing and development of segment-specific products. ■