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The Economic Potential of Thin Film Solar Photovoltaic Technologies in Germany

Executive Summary

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Solar photovoltaic technologies and the German energy transition

The switch from fossil and nuclear fuels to renewable energies is a core element of the German "Energiewende".[1] This comprehensive transformation of the energy system will require multiple gigawatts of additional renewable energy capacity over the next decades. Electricity generation from solar photovoltaic (PV) systems plays an important role for the "Energiewende", as solar PV is expected to be one of the least-cost and most relevant sources of energy by 2050.[2] [3]

The share of renewable energies in German gross electricity consumption has increased from 24 percent to 36 percent between 2012 and 2017.[4] In 2017, power generation from PV amounted to 40 TWh (18 percent of all renewable power generation and 7 percent of all power generation). The cumulative PV capacity installed was at 42.3 GWp in 2017,[5] to which thin film PV contributed an estimated 10 percent (around 4.3 GWp).[6] In the same year, 1.66 GWp of new PV capacity required an investment volume of 1.7 billion Euro.[7]

Key characteristics of thin film PV

PV is the conversion of light into electricity using semiconducting materials. PV encompasses several technologies with different characteristics which are evolving rapidly as the global PV industry is growing. Thin film solar cells are made by depositing one or more thin layers of photovoltaic material on a substrate, such as glass, plastic or metal. Key characteristics of thin film PV are:

- **Competitiveness:** Economies of scale and technological improvements led to a steep decrease in module prices.[8] Performance of thin film PV technologies is competitive with other PV and electricity generation technologies.[9]
- **Environmental footprint**: Energy and material efficient manufacturing enables lowest resource use and emission profiles for thin film PV technologies.[10] Due to the low material input used, thin film panels have a small environmental footprint.

- **Innovative potential**: Emerging thin film technologies have a great potential for further technological improvement and cost reduction.[10]

The thin film PV value chain in Germany

The thin film PV value chain in Germany comprises activities over the whole PV life-cycle. The PV life-cycle encompasses raw material sourcing, manufacturing of modules, the deployment, operation and dismantling of PV systems as well as end-of-life disposal or recycling. Other important segments of the value chain are manufacturing of components, manufacturing of machinery and equipment for the production of modules and research and development. These products serve as inputs to the module manufacturing process in Germany and abroad. Our analysis of firms operating in Germany shows that the German thin film industry serves both the German and the global market and covers all segments of the PV value chain.

Policy scenarios and implications for PV installation

The worldwide expansion in PV capacity amounted to around 100 GWp in 2017, representing a year-on-year market growth of over 30 percent.[11] Steep global market growth is expected to continue. Fraunhofer ISE estimates a rise in the global cumulatively installed capacity to 5,200 GWp by 2035.[12] Large investments in PV are also foreseeable in Germany. Agora Energiewende finds that in order to increase the share of renewable energies to 65 percent of gross electricity consumption by 2030, an annual PV expansion of 5 GW between 2020 and 2030 is necessary.[13] This expansion path and assumed investment costs of 1 billion Euro/GWp imply an estimated annual economic potential of PV of EUR 5 billion in the upcoming years.

The future economic potential of PV in Germany

Thin film PV technologies are low-cost and ecologically sustainable technologies for electricity generation. They compete in performance with other PV and electricity generation technologies and exhibit a high innovative potential. PV is one of the major future energy generation technologies and the global PV market will exhibit high growth. In Germany, substantial investments in PV will be undertaken to reach the goals of the energy transition (*Energiewende*). The German thin film PV industry is highly innovative and serves both the German and the global market. Firms operating in Germany

cover all segments of the thin film PV value chain. Moreover, the German industry can draw on a well-established knowledge base with top-level research and development institutions.

Jointly, these factors determine a high economic potential of thin film PV in Germany. A supportive, technology neutral policy framework would facilitate the realisation of this potential with respect to jobs and economic growth in Germany.

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