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The Next Feedstock Transition

The last century has witnessed the dramatic growth of the energy and chemicals industry, fueled by a steep rise in world population, exploding demand for products, breakthroughs in catalysis and polymer sciences, and finally the switch from coal to relatively cheap oil and gas as a feedstock. In the coming decades, further growth and change are to be expected, induced by a continuing rise in world population, the sustainability imperative, substantial progress in bio- and nanosciences, and a gradual switch from fossil-based resources to renewable resources.

To provide a general backdrop to the material presented in this book I should like to offer a few insights gathered during my career in one of the leading energy and chemicals companies, Royal Dutch Shell. Let us start with reminding ourselves that the golden age of chemocatalysis was brought to the fore by the availability of abundant and relatively cheap oil and gas – created by biomass decomposition over millions of years. These resources are characterized by, relative to coal, low to medium range molecular weights, high H/C ratios, and chemical stability upon storage. Over time, the industry has developed an impressive series of thermal and chemocatalytic processes to convert these resources into fuels, lube oils, and chemical building blocks, such as syngas, olefins and aromatics. In a next set of processes, the chemical building blocks are then functionalized to yield aldehydes, acids, esters, amides, aliphatic oligomers and polymers for use in manufacturing of the chemical products that enabled our modern ways of living. Molecular transformations include oxidation, amination, (de-)hydrogenation, desulfurization, denitrogenation, (hydro-)cracking, hydroformylation, polymerization, and so on. The chemical stability of the fossil resources – brought along by the predominance of C–H and C–C bonds in the feedstocks – forces the industry to apply high temperatures and pressures in (especially) the primary conversion processes. The resulting capital intensity has driven the industry to building ever larger plants enjoying very high space time yields and efficient energy management.

It is my firm conviction that the very extensive knowledge and experience base gained through the conversion and upgrading of fossil resources will be a key contributor to the technology revolution needed to move towards an economy that is based on biomass. Firstly, a number of existing conversion technologies will – with some minor adaptations – be employed for the production of alkanes and