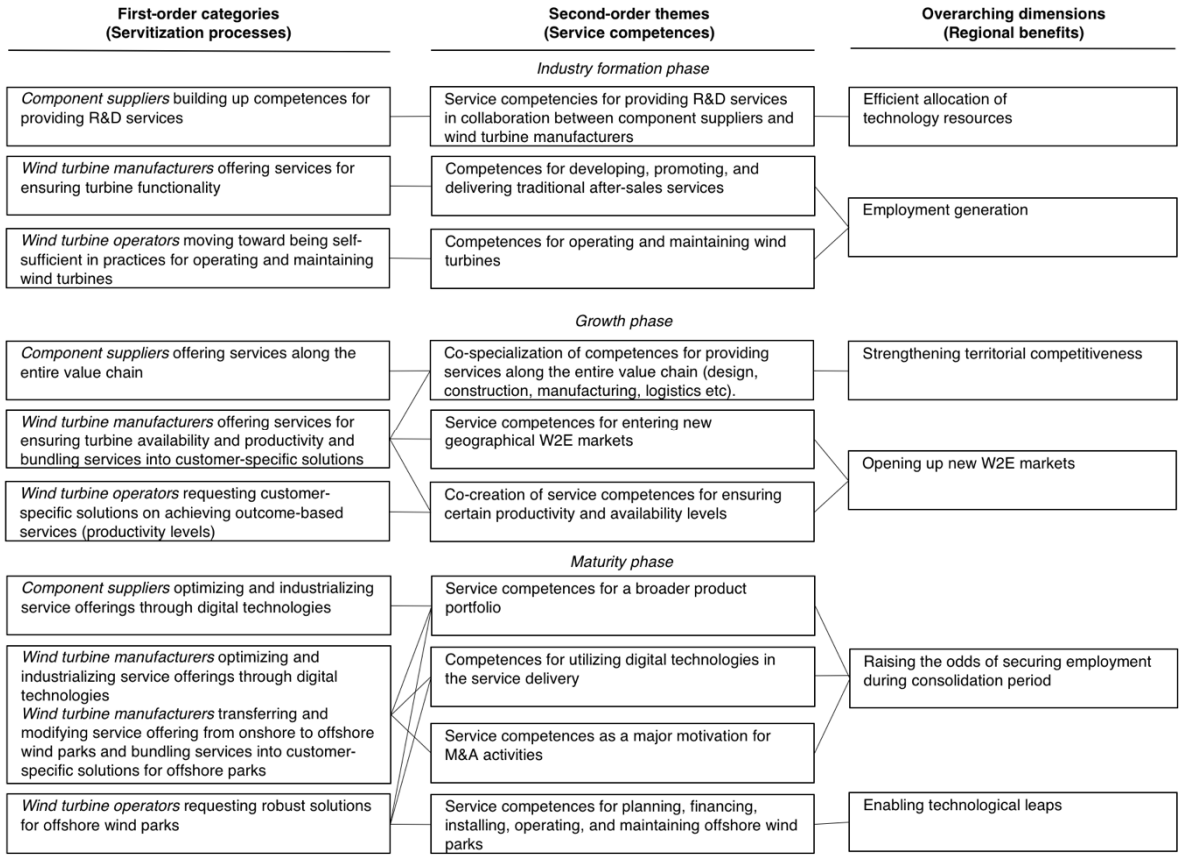
APPENDICES

Appendix A: Overview of the interview partners

Interview number	Organizational function of the participant	Company and position in the value chain
	Participants from companies (functions)	
1	Member of management team	Supplier for vibration systems, structural mechanics, acoustics and emission control systems
2	Sales manager	Supplier of power transmission systems
3	Vice president sales	Supplier of pitches and gears
4	Head of R&D	Supplier of heavy duty hydraulics
5	Key account manager	Supplier of vibration monitoring systems
6, 7	General manager Head of service business	Supplier of rotor blades
8, 9	Service business development manager Solution director	Wind turbine manufacturer
10, 11	Sales director for solutions Service business manager	Wind turbine manufacturer
12	CEO (Chief Executive Officer)	Wind turbine manufacturer
13	Sales and Service leader	Wind turbine manufacturer
14	Sales director for solutions	Wind turbine manufacturer
15	Director customer service (Europe)	Wind turbine manufacturer
16, 17	Head of wind park operation General manager, operation & maintenance	Wind park developer and operator
18	General manager, wind park development	Public utility operating wind parks
19	Director of wind energy	Business unit in a Wind-to-Energy and Solar energy specialist, Wind park operator
20	Technical support for wind parks	Wind park operator
21	Regional sales manager Wind park specialist	Independent power producers / wind park operator
22	Head of wind power	Renewable energy business unit in a public utility, Wind park operator
23, 24	Wind park manager Account manager	Multinational electric utility, Wind park operator
	Participating industry experts (function and organization description)	
	Function of the participant	Organization
25	Team leader offshore activities	Organization for promoting and advocating offshore activities
26	Member advisory board	Danish Association on wind energy
27	Director	German Wind Energy Association
28	Vice president	Offshore Wind Working Group in the German Wind Energy Association
29	Account manager (Europe)	Global Wind Energy Council
30	Director	WindEurope
31	Director	Asociación Empresarial Eólica (AEE)
32	Director	Danish Wind Turbines Owner Association
33	Director	Danish Wind Industry Association
34	Leader manufacturing association	Spanish Wind Energy Association

Appendix B: Framework on territorial servitization



Appendix C: Representative quotes and archival entries underlying second-order themes.

Theme 1a: Efficient allocation of technology resources	
Second-order themes	*First-order categories: Selective evidence from the interviews (interview quotes) and secondary data*
Service competencies for providing R&D services in collaboration between component suppliers and wind turbine manufacturers	– … it was critical to anticipate whether to develop turbines using constant and/or variable rotational speeds. … it looked like that constant speed would become the dominant product design, since the percentage increased from 65% to 75%. However, some years later, only 15% of wind turbines relied on a constant rotational speed. With 85% of the total capacity, variable speed became the dominant design. – In 1993, 81% of the generators were induction generators and 18% synchronous generators. In 2003, these generator types were reduced to 51% and 49% of the generators were now doubly fed…. R&D services played an essential role in predicting generator development… – R&D collaboration with suppliers helped us to predict the changes in the aerodynamic control systems… initially, 70% of all aerodynamic control systems were stalls, and 30% were pitches. Ten years later, only 14% were stalls and 86% were pitches… – In the 90s, wind turbines became much larger… Despite rapid growth, developing larger wind turbines stretched the R&D resources in the entire industry… Thus, R&D collaborations between suppliers and wind turbine manufacturers were important… Collaborations improved the prediction of emerging dominant product designs – Service practices were quickly shared among customers – Our customers quickly learned how to operate and maintain the wind turbines
Theme 1b: Employment generation	
Competencies for operating and maintaining wind turbines	– Our initial customers were farmers who were keen on becoming self-sufficient, producing their own electricity – Customers wanted to service the wind turbines themselves. – Regional policy makers incentivized wind turbine investments, because it created employment opportunities in the region
Competences for developing, promoting, and delivering traditional after-sales services	– Without the need to invest in services, we could increase our international sales rapidly … from the early start, 50% of revenue came from our home country and 50% from other countries… – Since we did not initially have to invest into services, we could become profitable faster. – Our industry had grown driven by peaks in oil and gas prices, efforts to reduce CO2 emissions and to achieve energy self-sufficiency… focusing on products allowed us to rapidly internationalize – Since the early start, companies producing wind turbines, blades, rotors, generators and so on, achieved attractive international and domestic growth…

Close ties for service competences hinder the relocation (offshore) of manufacturing capacities	– We could keep the manufacturing capacity in our region, since all activities in the value chain were closely linked through exchanging services. – Service competences played a key role in making manufacturing capacities stick to our region
Theme 2a: Opening up new W2E markets	
Service competencies for entering new geographical W2E markets	– IPPs wanted us to support them in conducting wind measurements and in operating and maintaining the turbines, and in assuring the grid connections. – Utilities entering the wind-to-energy market demanded long-term service agreements and turnkey solutions. – Advanced services helped us to tap successfully into the IPP and public utility segment. – Thanks to being able to provide services for these new customer segments, we could increase sales between 2004 and 2008 from 49 to 122 GigaWatt). – To win this battle for growth, the services we provided to our early customers became decisive…. We learned from maintaining these older turbines and leveraged these lessons into maintenance services for new customers… – Service competences opened up the new segments … These segments quickly represented 58% of total revenue – When we saw a first wave of acquisitions, we feared that our region would lose highly-specialized jobs, because production capacity might be relocated … – General Electric and Siemens became interested in wind energy…. but wind was just one of the energy segments …. what was important was that they had critical competences for servicing equipment in the oil and gas industry, and other power generation and transmission segments. Theses service competences helped them to enter the wind industry…. – The service competences brought in by these firms pushed the entire industry … other firms also quickly expanded their service competences. – General Electric (GE) acquired Enron as it faced bankruptcy securing the future of Enron capacity in Germany and the United States. As a new business division, GE Wind invested in competences making the Enron acquisition one of the major wind turbine players. Germany, as Enron's focal territory, benefited from the acquisition through securing employment and supplier competences. – When Suzlon took over RePower, many people feared that the Indians would replace away German engineering skills… however, RePower went through a couple of crises together with Suzlon… nevertheless, RePower could retain a strong position by protecting its service competences and intellectual property. … today, RePower has almost doubled its employment…
Co-creation of service competences for entering new geographical markets	– We specialized in competences for providing four solutions: simple turbine supply, supply and installation, services and turnkey solutions… These service competences reduced the risk of relocation. – … we offer advanced availability and productivity solutions… the competences could not be relocated. – Our wind turbines installed in the 1990s were aging… making maintenance procedures more complex. … Customers were no longer willing to maintain the wind turbines themselves. – There was a need to develop new service competences

	– These more complex maintenance procedures were increasingly beyond our customer competences… Customers wanted to have more service support.
Theme 2b: Strengthening territorial competitiveness	
Co-specialization of competences for providing services along the entire value chain (design, construction, manufacturing, and logistic services)	– … during the construction phase, we deliver the turbine to the customers. Customers have specialized subcontractors for erecting the turbine and connecting it to the grid. – Availability solutions guarantee that the turbine would rotate for a certain amount of time per year. Productivity solutions ensure that the turbine produces a certain amount of energy per year… competences for such solutions strengthen our regions… competences were highly embedded in our value chain. – Utilities look for high-quality durable turbines and are willing to pay a price premium for them… This pushed our industry and led to sustainable competitive advantages and attractive profitability, which in turn enabled the industry to increase technology advantages. – Utilities calculate the long-term effects of investing in wind on their entire energy generation portfolio. This long-term perspective pushed us to improve our turbine quality, including the quality of all suppliers. Utilities were willing to pay a price premium for such high-quality products, which gave us a considerable competitive advantage, and improved our profitability…. This enabled us to invest more into innovations for maintaining our technology advantages. – By collaborating with utilities, we learned that many sites do not have high wind-speeds…. We designed a new wind turbine suitable for low- to medium wind speed. – In our collaboration with utilities, we learned that it is much easier to get building permits for wind parks, if wind turbines do not produce too much noise... We developed a new wind turbine suitable for low- to medium wind speed and for operating within a low decibel range.
Theme 3a: Raising the odds of securing employment during consolidation period	
Service competencies for a broader product portfolio	– When we started to offer availability and productivity solutions, … we needed to be flexible in terms of turbine sizes, quality levels and lifetimes. – By relying on medium as opposed to high quality and costs, Gamesa tapped successfully into emerging markets and at the same time kept a strong hold on its domestic Spanish market. In 2016, 71% of Gamesa's order intake came from emerging markets such as China, India, and Latin America. Even producing most of the turbines in China, India, and Brazil, Gamesa did not reduce employment in Spain. Instead, some employments changed from production to services, as Gamesa started to serve its installed capacity. – … we are the most international wind turbine producer, with production facilities in eight countries. We also offer a variety of turbines sizes and lifetimes… One turbine is produced, for example, completely in China and sold there exclusively. … we sustained employment in our home country… and simply strengthened the competitive advantages of offering less advanced turbines for emerging markets. – In 2010, there was fear that the European industry would lose its pioneering role to Chinese competitors .... Chinese Goldwind, for example, nearly tripled its revenue between 2008 and 2010 … while

	European companies struggled financially. – The financial crisis accentuated changes in the customer mix, and led to a few large utilities dominating the market. – During the financial crisis, of course, some customers looked with interest at lower quality turbines, but were discouraged, as banks place a high-risk premium on such turbines. Most turbines produced in emerging markets are still sold in local markets and not in Europe. – … servitization enabled us to tap into the utility segments and based on that we were competitive enough to keep prices even during the financial crisis. – The financial crisis led to consolidation in terms of forcing small customers out of the market with large utilities with stronger cash flows taking over their assets. – … servitisation enabled us to tap into the utility segments and based on that, we were competitive enough to keep prices even during the financial crisis. We are the Mercedes of the wind industry.
Competencies for utilizing technologies in the service delivery	– "… we now continuously monitor 16'000 turbines and provide … optimization services for them. Such services … require highly experienced service engineers… We … locate these competencies in our headquarters.
Service competencies as a major motivation for M&A activities	– Siemens merging with Gamesan, and Nordex with Acciona. In such M&As, service competences played a key role that the integration of these companies strengthens the overall market position. Acciona, for example, contributed to the merger with valuable service competences on developing new wind park projects, which in turn now generates a major share of Nordex revenues on wind turbines installed in these parks.
Theme 3b: Enabling technological leaps	
Service competencies for planning, financing, installing, operating, and maintaining offshore wind parks	– In offshore, the turbine accounts only for 45% of the total cost, the rest is installing underwater cables, connecting the turbines … Installation, operation and maintenance costs are three times higher for offshore than for onshore solutions. – We developed a 3.6 MW turbine with a rotor diameter of 104 meters and a swept area of 8,495 square meters. The turbine was designed specifically for high-speed offshore sites. – R&D services (collaboration) to push offshore technologies was observed for pitch-and-yaw regulators. The pitch adjusts the blade's angel of "attack" leading to optimized rotational speed and lift-to-drag ratio at any given wind speed. Yawn control keeps the turbine facing the wind. – R&D services (collaboration) to push offshore technologies were also observed for active vibration damping, which reduces tower oscillation, resulting in greater drive train reliability, which would ultimately reduce maintenance costs and increase turbine lifetime. – Service costs are three times higher for offshore than for onshore and highlight why service competences for operating and maintaining the product became critical. – New firms specializing in tailor-made vessels to bring down the installation time for large offshore wind parks – Our onsite maintenance staff needs to communicate …but mobile telephones had limited coverage in these offshore areas, and were not very robust… so we were very happy when a new firm offered us a heavy-duty communication solution which coped with extreme temperatures and high levels of dust inside these turbines.