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ESMT INNOVATION INDEX 2012 – ELECTRICITY SUPPLY INDUSTRY

CHRISTOPH BURGER, ESMT CS
JENS WEINMANN, ESMT CS

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* Contact: Christoph Burger, ESMT, Schlossplatz 1, 10178 Berlin, Germany
Phone: +49 (0) 30 21231-8040, christoph.burger@esmt.org.

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Executive summary

The ESMT Innovation Index 2012 – Electricity Supply Industry measures innovation activities of 16 major European utilities. In addition to expenses on research and development (R&D), patents and research areas, it also takes indicators for process innovation into account, in particular the utilities' performance regarding productivity and sustainability.

Portuguese utility EDP achieves the highest score in the overall ranking of the ESMT Innovation Index 2012, followed by EDF, RWE and Iberdrola.

Despite a challenging market environment, the 16 European energy utilities analyzed in the ESMT Innovation Index increased their aggregate R&D budget by 3 percent between 2010 and 2012. While utilities like EDP, Iberdrola, and Statkraft focus on improvements in the dissemination of innovations ("Dissemination Leaders"), companies like EDF and RWE spend substantial resources on in-house research and development, and have a successful track record in patents ("Research Leaders"). Nonetheless, 6 out of 16 utilities have decreased their R&D spending during the observation period. Within the sample, 9 utilities show only lackluster efforts in innovation ("Hesitants").

By contrast, all utilities have improved their rating in the sustainability subindex between 2007 and 2012. Energy generated from new renewables resources (i.e., all CO_2-free sources except hydropower) rose from 48 to 136 TWh over the observation period. 14 companies were also able to increase their productivity.

The ESMT Innovation Index 2012 may serve as a wake-up call, because not all European utilities have realized that they need to strengthen their innovative potential for turbulent times ahead.

The erosion of the utilities' traditional business model

The European electricity supply industry faces sudden and drastic changes to its traditional business model. Decentralized and renewable energy generation turns the previous one-way street from power generation to load centers upside down, and millions of European consumers become producers. In addition, new entrants from other industry sectors threaten the dominant position of the established companies.

Innovation in large technical systems like the electricity grid occurs at lower pace than in industries like manufacturing, information and communication, or financial services: path-dependence due to the capital-intensive nature of the assets, interdependencies between technical components, standards and societal routines contribute to a high level of inertia in the overall configuration of the system (Markard and Truffer, 2006). Over its 100 years of existence, the electricity grid has developed even more slowly than other large technical systems: "Alexander Graham Bell would not recognize today's telephone network, but Thomas Edison would feel right at home running our current electrical grid." (Tapscott and Williams, 2010)

Since the beginning of this decade, though, the traditional business model of European electricity incumbents has come under attack: Unprecedented amounts of residential users have installed photovoltaic (PV) panels on their rooftops and have become self-producers; private investors, co-operatives and municipal utilities together with local residents have set up funds to invest in wind parks; new entrants from other sectors like the automotive industry, manufacturing or internet and communications technology (ICT) have discovered that electricity markets are a promising new playing field with multiple new applications like micro-combined heat and power (CHP) plants, smart homes or time-sensitive billing. For example, German car manufacturer Volkswagen has entered an alliance with electricity retailer LichtBlick to sell micro CHP plants to German households, companies like Vodafone engage in initiatives to explore business opportunities related to smart homes, and the European demand response market is slowly evolving with players like Kiwi Power and Flexitricity in the UK, Entelios in Germany, or Cybergrid in Austria, of which a 76-percent stake was acquired by Toyota in July 2013.

The pace of these changes even exceeds the EU's transition from rate-of-return regulation and monopoly conditions to liberalized markets in the late 1990s. Governments in many European Member States have been taken by surprise how

successful their policy incentives to promote renewable energies have become. Generous feed-in schemes in countries like the Czech Republic, Germany or Spain place an increasing burden on state budgets and final consumers' electricity bills, and have been curtailed in their duration and size. With the price of the installation of a PV panel having fallen by more than 50 percent between 2006 and 2012, grid parity[1] is looming in many countries, in particular in sunny Southern Europe. If it becomes equally expensive to buy electricity from the local provider or to self-produce it, the rise of decentralized energy supply is likely to continue, irrespective of reduced state subsidies.

In addition, the peak in solar radiation coincides with the typical midday demand peak. On spot markets for electricity like the European Energy Exchange (EEX) in Leipzig, Germany, wholesale prices are continuously falling, thereby depriving utilities from previously secure revenue streams. While a Megawatt hour of electricity on the EEX spot market cost around €55 in 2011, it was sold at €36 in September 2013 (Flauger, 2013) – a decline by more than a third. Peter Terium, RWE's CEO, even coined the situation of the electricity sector as the "worst crisis of all times" (Student, 2013).

The drastic increase of decentralized generation turns out to be a game-changer for utilities: They are suddenly faced with Schumpeter's process of "Creative Destruction" – if they do not explore new ways of making profits, they are doomed to be marginalized, overrun by new entrants and reduced to cost-plus-X-regulated service providers in charge of the transmission and distribution grid. Stock markets are pessimistic about the future of these companies: The shares of European electric utilities have been the worst performers among 19 major sectors since early 2008, while the Eurozone-only utilities index lost €312 billion in market capitalization (De Clercq, 2013). Which strategies do European electric utilities choose in such a situation?

The ESMT Innovation Index tracks and identifies their approaches to innovation. Following Schumpeter, we understand innovation as a larger process of organizational change that encompasses not only R&D activities of companies, but also improvements in their productivity and sustainability. Despite 2 modifications in the composition of the set of indicators (see appendix 2 for a description), we maintain the basic structure of the index with its 3 dimensions: The Research Subindex monitors the importance, efforts and diversity of R&D undertaken by electricity utilities, the Sustainability Subindex assesses the integration of new and

[1] I.e., achieving a stage of development of PV, wind or biomass technology, at which it is competitive with conventional electricity sources at given retail prices.

environmentally sound sources of energy and reduction of CO_2 emissions, while the Productivity Subindex measures operative and sales performance of the companies.

The first release of the ESMT Innovation Index 2010 received widespread feedback from companies included in the index as well as those not yet analyzed. We have extended the sample to German utility EnBW, which became independent from EDF again in 2010. The raw data underlying the second release of the Index has been sent to all utilities for clarification and, if necessary, corrections. We want to express our gratitude to all those who have helped to establish and improve this unique dataset of innovation efforts of major European electricity companies.

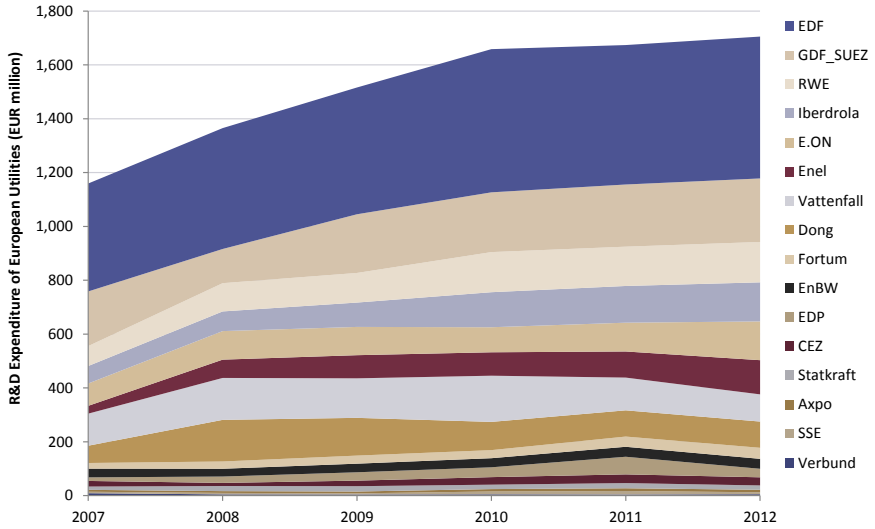
Key findings of the ESMT Innovation Index 2012

The ESMT Innovation Index 2012 – Electricity Supply Industry measures innovation activities of 16 major European electricity utilities in 3 dimensions: research, productivity and sustainability. While the overall R&D budget in the sample has steadily increased, more than half of the companies show only modest innovation efforts and score low on the Index. Within the remaining sub-sample of 7 companies with higher scores, two distinctive innovation strategies can be observed: one strategy focuses on proper research activities like the development of new technologies, while the other one emphasizes the efficient dissemination of existing technologies to increase productivity and sustainability.

Spending on R&D of major European energy utilities has increased by three percent since 2010

Between 2007 and 2012, the combined R&D budget of 16 major European energy utilities grew by 47 percent – from €1.16bn to €1.71bn. This finding questions the hypothesis that the change of the European regulatory regime to liberalization and competition reduces the utilities' incentive to undertake own research and development (see e.g. Jamasb and Pollitt, 2008, Jamasb and Pollitt, 2011, Kim et al., 2012, Sterlacchini, 2010). It rather seems that the multiple challenges described in the introduction have had a stimulating effect on the innovation activities of European electricity companies.

Figure 1: R&D spending of major European energy companies



Note: Companies are sorted by total R&D expenses in 2012.

Source: ESMT analysis (2013).

As figure 1 shows, since 2010 the overall R&D budget of the sample companies has flattened, though, with an overall increase of only 3 percent. Some of the companies even decreased their R&D spending, mostly smaller and medium-sized utilities, but this drop was compensated by additional spending of the remainder of the cohort[2]. Since market conditions have substantially worsened during the last two and share price have been in decline, the overall increase may be interpreted as an indication that innovation is still considered an asset for most utilities.

Other indicators also suggest that interpretation. For example, the number of research areas covered by both in-house R&D and research collaborations steadily increased in the sample. Between 2010 and 2012, 10 electric utilities started research in areas in which there were not active before, like decentralized energy generation, storage, or preservation of the environment and biodiversity.

A similarly positive trend can be observed in the number of scientific publications in peer-reviewed journals, too. The number of papers to which at least one person with a declared affiliation with the respective companies contributed increased by more than 50 percent from 2007 to 2012 – from 80 to 121 in a sample set of

[2] To facilitate direct comparisons, appendix 1 provides the complete dataset underlying the analysis.

journals released by incumbent academic publisher Elsevier[3]. By contrast, after a continuous rise until 2010 the number of new patent applications dropped substantially from 342 in 2010 to 105 in 2012. Reasons for that decline have to be further explored, although there is anecdotal evidence, for example in the Gartner Hype Cycle, of a peak of expectations of emerging technologies like Smart Grid, advanced metering infrastructure or electric mobility, which fostered a range of inventions like roaming services at electric vehicles' charging stations, 2 to 3 years ago.

Differing strategies between Research Leaders, Dissemination Leaders, and Hesitants

Our analysis reveals that innovation strategies of European energy companies can be differentiated according to 3 clusters: "Research Leaders", "Dissemination Leaders", and "Hesitants". As in the ESMT Innovation Index 2010, we use a Transformation Matrix to graphically distinguish the 3 sub-groups.

"Research Leaders", the first cluster, consists of companies that have developed a strong focus on in-house research activities or research collaborations. Compared to their peers and other utilities, they typically invest relatively large amounts of their operating profits in research and development projects and are active in a wide array of research areas. For example, French utility EDF spends more than €500m, or around 3.5% of its EBITDA, on R&D. These companies' employees have a successful track record on patents. In the ESMT Innovation Index 2012, the cluster "Research Leaders" includes French utility EDF, RWE from Germany and, to a lesser extent, Finnish utility Fortum.

In figure 2, these companies score high on the Research Subindex, which is depicted on the horizontal axis[4]. They are located in the bottom right quadrant.

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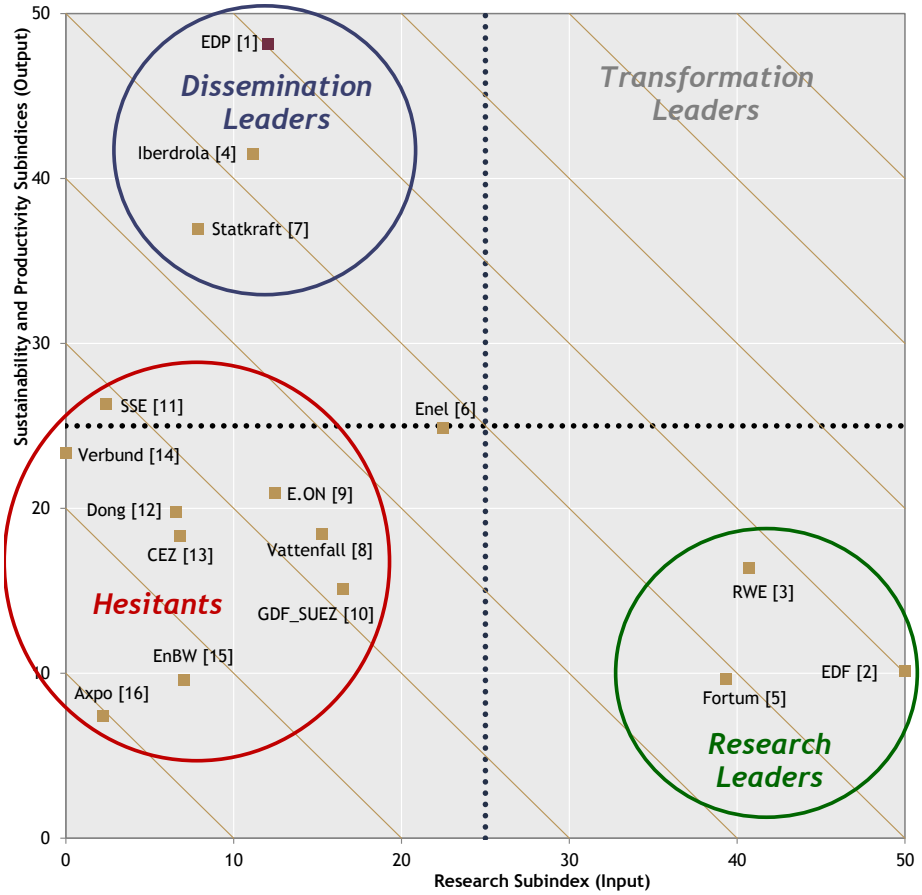
[3] To ensure a high degree of continuity with the methodology of the ESMT Innovation Index 2010, we have decided not to include figures on Elsevier publications as an additional indicator in to the 2012 version of the Index. However, for comparisons among the utilities the data is listed in appendix 1.

[4] The Research Subindex comprises the indicators absolute R&D budget, relative R&D importance (which is the ratio of the overall R&D budget to EBITDA), number of patents (absolute and per 1,000 employees), and research diversity. For additional notes on the indicators, please see appendix 2 for a detailed description of the variables.

Figure 2: Company clusters based on ESMT Innovation Index 2012



Note: Numbers in brackets denote the overall rank in the ESMT Innovation Index 2012.

Source: ESMT analysis (2013).

The second cluster comprises the sample's Dissemination Leaders. In figure 2, they are located in the top left quadrant with a high ranking of the Sustainability and Productivity Subindices, which are depicted on the vertical axis. Those companies focus less on in-house research, but are successful in using and combining innovative processes and technologies to enhance their overall system performance.

The cluster contains 3 companies: Portuguese utility EDP, which has the highest score in the overall ranking of the ESMT Innovation Index 2012, Iberdrola from Spain, and Statkraft from Norway. Since the last release of the Index in 2010, both EDP and Iberdrola have increased the electricity generated by new renewables, i.e., all renewable energies except hydropower, by more than 20 percent, and demonstrate their innovative potential in the successful integration of these

technologies in the system as well as in increases of overall output and employee productivity. Their success shows that a decisive, strategic bet on renewable energies is a viable business model that paves the way into a low-carbon European supply structure where smaller electric utilities are still able to play an important role.

Figure 2 also shows that Italian utility Enel is the only company in the sample that combines intensive R&D efforts like the Research Leaders with the performance focus of the Dissemination Leaders. Together with German utility E.ON (+€37m), ENEL (+€30m) implemented the largest increase of its R&D budget from 2011 to 2012.

The third cluster in the graph comprises the remaining 9 companies, the Hesitants. They tend to perform more strongly in the Sustainability and Productivity Subindices than in the Research Subindex, which can be observed in the slight bias of the cluster towards the vertical axis. Most of the companies can be characterized by little to modest expenses on R&D, but also a moderate performance in productivity and/or sustainability. However, companies like E.ON have a number of innovative projects in the pipeline, for example offshore wind farms or demand response products for industrial customers, which have not yet materialized in our metrics but might translate into higher performance scores with a delay. In addition, many of the Hesitants are still in a fairly comfortable financial position: Only 4 utilities have experienced declining EBITDAs over the observation period, namely Axpo, Dong, E.ON, and EnBW, whereas the other 5 companies have been able to maintain or even improve their financial performance. Hence, the urgency of fostering innovation in either strategic direction seems to be limited.

Sustainability and productivity high on the agenda of utilities

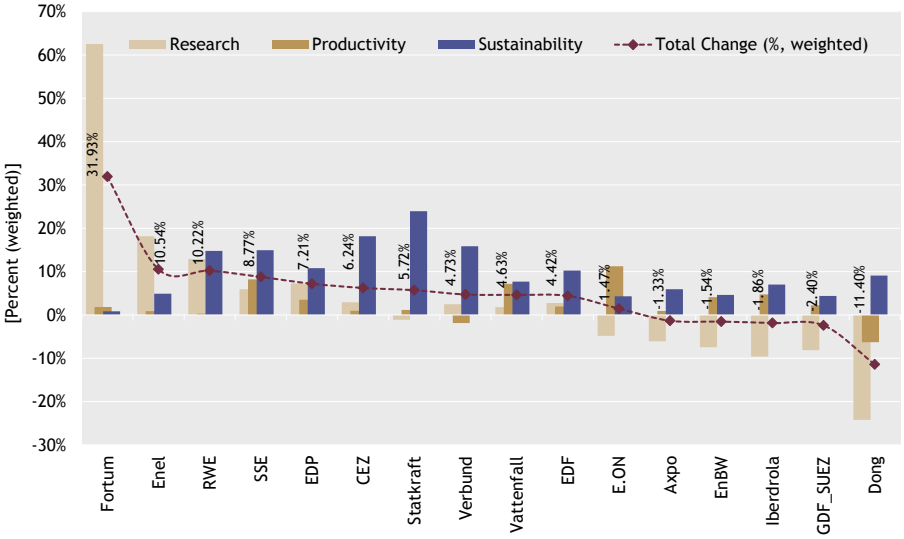
Our analysis reveals that European utilities demonstrate commitment to sustainability. The performance changes for the time span 2007 to 2012 show a consistently positive evolution with respect to sustainability indicators. All utilities in the sample were able to improve their sustainability rating, as depicted in the Sustainability Subindex, mainly due to energy generated from new renewables resources (i.e., all CO_2-free sources except hydropower), which rose from 48 to 136 TWh over the observation period. The climate performance, i.e., the energy output per ton of carbon dioxide, remained stagnant at around 2.75 MWh/t CO_2.

Except Austrian utility Verbund and Danish utility Dong, all companies were also able to increase their productivity, as measured in the Productivity Subindex.

By contrast, changes in the Research Subindex reveal a mixed track record: 6 out of 16 utilities have decreased their innovation efforts over the last 5 years, while the greatest improvements were observed with Fortum, Enel, and RWE.

In figure 3, performance changes over the entire observation period in all 3 Subindices are shown.

Figure 3: Performance changes (in % from 2007 - 2012)

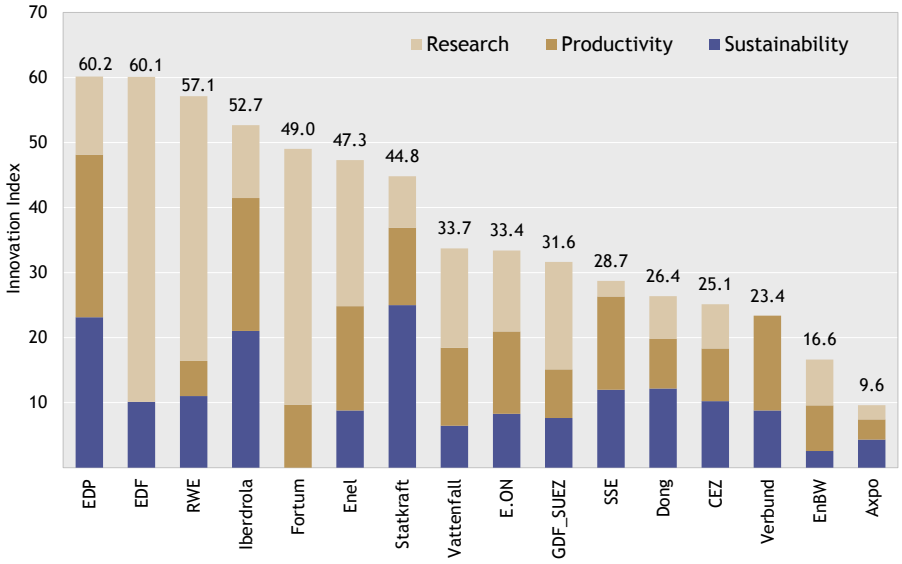


Source: ESMT analysis (2013).

EDP and EDF lead the overall ranking

Energias de Portugal (EDP) receives the highest score in the overall ranking of the ESMT Innovation Index 2012. With a marginal distance of only 0.1 points Electricité de France (EDF) achieves the second rank, followed by RWE and Iberdrola.

Figure 4: Ranking and composition of ESMT Innovation Index 2012



Source: ESMT analysis (2013).

As shown in the Transformation Matrix in figure 3, EDP achieves its leadership position as a Dissemination Leader by emphasizing process innovation in productivity and sustainability. The company also established a prototyping laboratory and an open innovation website, where new ideas can be shared[5].

By contrast, French utility EDF is characterized by a strategy of a Research Leader, as the composition of the index and the position in the Transformation Matrix show. While productivity and sustainability have a comparatively low strategic importance, of all energy utilities in the sample EDF has by far the highest R&D budget over the observation period. Since 2010, the budget has consistently exceeded €500m – more than double of what GDF-Suez, the next company in the R&D budget ranking, spends and almost matching the entire budget of the Electric Power Research Institute (EPRI), which bundles industrial R&D activities of all major US American utilities. EDF has streamlined its research into 3 areas: strengthening the Group's nuclear expertise, developing the full spectrum of

[5] According to information retrieved from company website in September 2013.

renewable energies - solar, wind, marine - including new power-storage solutions, and electricity planning, which includes research on network asset management, optimized models and economic scenarios for transport infrastructures, and building smart grids. In 15 departments, 12 joint laboratories and 7 international centers, the company employs 2,100 people working in R&D, 200 researchers lecturing in universities and Grandes Ecoles, and 150 doctoral candidates[6]. Within our sample, EDF is responsible for more than a third of all patent applications.

The overall ranking of the ESMT Innovation Index 2012 shows a clear division between top scorers and hesitants, with RWE, Iberdrola, Fortum, ENEL, and Statkraft joining EDP and EDF in the leading group. The mix between smaller and larger utilities within the leaders' group indicates that smaller players are also able to realize their innovative potential.

As a recent report by the pan-European sector association Eurelectric states: "From a relatively peripheral phenomenon, innovation now is central to fundamental shifts in power sector value creation as well as a precondition for achievement of societal objectives. All power sector participants – from equipment manufacturers to energy retailers – will need to find new ways to improve their products and manage their businesses." (Eurelectric, 2013) The association estimates that "accelerated innovation in power supply technologies and business models for energy efficiency could be worth €70bn Euro to the EU economy in 2030." (ibid.)

The ESMT Innovation Index 2012 may serve as a wake-up call, because not all European utilities have already realized that they need to strengthen their innovative potential for turbulent times ahead.

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[6] According to information retrieved from company website in September 2013.

Appendix 1: Input data

Figure 5: Summary of key input parameters of ESMT Innovation Index, 2007-2012, by company (1/2)

		Axpo	CEZ	Dong	E.ON	EDF	EDP	EnBW	Enel	Fortum	GDF_SUEZ	Iberdrola	RWE	SSE	Statkraft	Vattenfall	Verbund
Electricity Production																	
Total (TWh)	2007	33.08	73.79	20.53	239.80	610.60	48.59	67.80	150.79	51.10	239.60	124.42	216.10	47.93	44.90	180.00	28.31
	2008	37.20	67.60	18.54	317.60	610.60	48.91	63.79	253.20	63.20	276.00	141.27	224.10	39.70	53.40	173.00	28.66
	2009	38.31	65.34	18.07	300.90	618.50	54.28	62.21	267.80	64.10	295.60	142.78	187.20	47.06	56.90	164.00	29.92
	2010	36.60	68.43	20.14	276.10	630.40	59.28	62.89	290.18	69.80	335.00	153.59	225.30	47.68	57.40	172.40	31.08
	2011	35.85	69.21	20.42	271.20	628.20	58.39	59.03	293.86	72.70	359.00	145.15	205.70	46.39	51.50	166.70	29.75
	2012	37.33	68.83	16.11	263.20	642.60	54.66	59.05	295.80	73.10	346.00	134.40	227.10	36.89	60.00	178.90	35.23
Thermal (TWh)	2007	1.26	45.95	17.30	134.00	119.10	28.51	21.30	92.24	6.20	150.90	73.01	178.50	43.50	1.50	95.09	3.99
	2008	5.54	39.50	15.96	209.62	114.18	26.81	18.30	146.30	16.60	171.74	87.93	169.00	34.10	5.40	90.23	3.35
	2009	6.88	35.54	15.26	199.90	95.80	25.85	18.70	149.30	20.60	189.18	86.49	144.70	42.00	6.10	86.25	2.71
	2010	7.04	37.33	16.14	172.40	96.50	19.71	21.90	156.70	25.80	214.40	80.44	169.00	42.90	6.60	89.70	4.26
	2011	4.64	37.51	16.00	180.70	81.50	20.26	22.90	171.60	26.80	247.71	74.38	160.40	38.38	4.60	85.00	5.41
	2012	5.39	34.32	11.50	174.00	98.50	19.73	24.44	170.30	24.50	245.66	64.69	181.20	29.30	1.50	81.70	4.50
Nuclear (TWh)	2007	23.24	26.17	-	77.60	440.30	-	38.30	15.53	24.90	40.78	22.22	32.40	-	-	50.66	-
	2008	22.79	26.55	-	76.22	439.02	-	37.30	32.90	23.70	46.30	24.74	49.80	-	-	45.06	-
	2009	22.28	27.21	-	71.80	466.10	-	35.50	31.84	21.40	56.41	22.83	33.90	-	-	42.32	-
	2010	21.38	28.00	-	72.60	475.60	-	32.90	41.15	22.00	50.25	26.11	45.20	-	-	43.60	-
	2011	23.00	28.28	-	60.90	500.10	-	28.38	39.50	24.90	43.08	24.29	34.30	-	-	42.50	-
	2012	22.48	30.32	-	57.40	485.40	-	25.80	41.40	23.40	38.06	26.03	30.70	-	-	48.90	-
Hydropower (TWh)	2007	8.42	1.22	0.97	21.70	48.70	14.99	8.20	35.49	20.00	43.13	15.88	3.70	3.90	42.70	31.00	24.32
	2008	8.69	1.13	0.97	22.23	53.12	12.89	8.19	64.30	22.90	49.68	11.60	3.40	3.59	47.40	34.00	25.31
	2009	8.91	2.11	0.97	18.50	49.90	15.41	8.01	76.10	22.10	41.96	11.97	5.50	3.40	50.10	32.00	27.10
	2010	7.99	2.33	0.97	16.90	49.80	22.68	8.09	80.80	22.00	56.95	21.63	5.70	2.93	50.10	35.40	26.71
	2011	8.02	1.90	0.80	16.30	37.10	18.94	7.22	70.20	21.00	50.26	17.75	5.00	4.63	46.00	34.50	24.22
	2012	9.18	2.10	0.80	17.20	46.30	14.24	7.98	68.70	25.20	48.44	11.90	6.40	3.14	57.60	42.20	30.49
New Renewables (TWh)	2007	0.16	0.45	1.96	6.50	2.50	5.10	-	7.52	-	4.79	13.31	1.50	0.53	0.70	3.25	-
	2008	0.19	0.42	1.99	9.53	4.27	9.20	-	9.70	-	8.28	17.00	1.90	2.01	0.60	3.71	-
	2009	0.24	0.50	2.28	10.70	6.70	13.03	-	10.56	-	8.05	21.49	3.10	1.66	0.70	3.43	0.11
	2010	0.18	0.78	3.46	14.20	8.50	16.89	-	11.53	-	13.40	25.41	5.40	1.85	0.70	3.70	0.11
	2011	0.19	1.52	3.70	13.30	9.50	19.19	0.53	12.56	-	17.95	28.72	6.00	3.36	0.90	4.70	0.13
	2012	0.29	2.09	3.80	14.60	12.40	20.69	0.83	15.40	-	13.84	31.78	8.80	4.45	0.90	6.10	0.24
CO_2 Emissions (mt CO_2)																	
	2007	0.51	38.83	13.80	121.30	57.95	23.42	19.00	59.80	10.40	89.91	41.70	187.10	22.70	0.29	94.90	3.41
	2008	2.25	33.77	12.60	147.50	91.60	19.78	16.40	110.60	17.60	99.57	40.80	172.10	19.30	1.60	91.40	2.89
	2009	2.80	37.18	11.90	144.90	72.50	20.04	16.90	122.20	21.80	98.23	39.90	149.10	23.10	1.60	89.70	2.22
	2010	2.84	38.85	11.80	116.70	75.70	14.74	20.92	116.20	25.30	111.41	39.30	164.90	24.50	1.69	91.50	3.25
	2011	1.95	38.74	10.80	124.59	70.50	16.96	18.70	123.20	23.50	148.80	36.19	161.90	24.89	1.16	88.60	3.66
	2012	2.20	35.02	7.80	125.76	79.80	18.05	20.60	127.50	20.70	154.23	35.71	179.80	24.50	0.48	85.00	2.90

Figure 6: Summary of key input parameters of ESMT Innovation Index, 2007-2012, by company (2/2)

		Axpo	CEZ	Dong	E.ON	EDF	EDP	EnBW	Enel	Fortum	GDF_SUEZ	Iberdrola	RWE	SSE	Statkraft	Vattenfall	Verbund
EBITDA (€m)																	
	2007	954.7	2,712.0	1,281.8	13,649.0	16,549.0	2,628.3	2,336.4	9,800.0	2,298.0	12,539.0	5,279.5	7,915.0	1,774.4	1,108.3	4,188.0	1,099.1
	2008	836.8	3,556.9	1,683.3	11,836.0	14,240.0	3,154.9	2,540.1	14,318.0	2,478.0	13,886.0	6,412.5	8,773.0	1,730.2	2,215.0	4,201.0	1,321.8
	2009	713.4	3,442.6	1,187.0	17,767.0	15,929.0	3,362.9	2,748.2	16,371.0	2,292.0	14,012.0	6,815.0	9,165.0	1,658.3	1,118.6	5,752.0	1,251.5
	2010	762.2	3,513.9	1,892.0	17,704.0	14,156.0	3,698.0	3,315.0	17,480.0	2,271.0	15,086.0	7,528.0	10,256.0	1,711.7	1,826.8	6,790.0	1,059.2
	2011	796.0	3,553.6	2,093.0	6,324.0	14,939.0	3,756.0	1,809.6	17,605.0	3,008.0	16,525.0	7,650.0	8,460.0	1,699.6	1,252.1	6,355.0	1,069.5
	2012	868.1	3,405.1	962.0	9,787.0	16,084.0	3,628.0	2,293.1	16,738.0	2,525.0	17,026.0	7,727.0	9,314.0	1,937.8	1,325.3	6,349.0	1,233.9
Employees																	
	2007	3,369	30,565	4,962	85,786	154,033	13,270	20,499	60,229	8,304	196,560	23,159	65,645	15,777	2,187	32,396	2,441
	2008	3,698	28,330	5,347	93,965	155,931	12,671	20,357	75,027	14,077	194,920	28,096	67,942	18,196	2,460	32,801	2,541
	2009	4,092	30,768	5,820	90,492	155,072	12,148	20,914	78,103	13,278	201,971	32,711	71,584	19,308	3,329	36,593	2,820
	2010	4,386	32,937	5,800	87,770	158,764	12,047	20,450	79,913	11,156	213,987	31,344	73,801	20,266	3,414	38,459	3,015
	2011	4,415	31,805	5,966	83,097	151,804	12,106	20,851	76,266	11,010	218,905	31,885	74,919	19,647	3,329	37,679	3,045
	2012	4,368	31,272	6,735	76,937	154,730	12,222	20,098	74,610	10,600	219,253	31,338	74,038	19,769	3,417	33,059	3,100
Total Investments (€m)																	
	2007	518.2	1,182.6	1,397.0	6,623.0	7,261.0	2,732.3	786.7	5,230.0	578.0	2,998.6	4,967.4	3,953.0	1,045.2	248.2	1,678.9	238.4
	2008	320.2	1,818.7	1,286.4	8,806.0	9,489.0	4,337.2	1,187.8	7,397.0	981.0	8,997.4	7,333.3	4,348.0	1,518.6	241.2	2,711.4	393.2
	2009	382.6	2,579.3	2,102.8	7,522.0	11,576.0	3,414.7	1,216.4	7,000.0	797.0	9,310.0	4,644.5	5,810.0	1,126.2	411.9	10,825.0	457.8
	2010	343.5	2,414.1	1,916.3	7,662.0	12,053.0	2,918.3	1,579.1	7,187.0	1,127.0	8,887.0	4,237.9	6,203.0	1,610.1	318.9	3,843.3	676.0
	2011	387.4	2,095.6	2,135.8	5,956.0	10,637.0	2,262.1	1,050.7	7,589.0	1,270.0	8,731.0	4,542.1	6,040.0	2,178.8	718.4	3,611.4	562.8
	2012	335.5	1,994.4	2,206.5	5,915.0	12,638.0	2,112.3	727.0	7,149.0	1,409.0	8,992.0	4,473.2	4,684.0	1,985.5	982.8	3,133.6	631.3
R&D Budget (€m)																	
	2007	7.1	20.8	64.2	83.0	401.0	13.3	32.4	29.0	21.0	203.0	65.0	74.0	5.4	12.2	119.2	9.0
	2008	6.5	11.4	154.7	106.0	449.0	23.7	28.9	68.0	27.0	127.0	73.1	105.0	5.5	19.1	155.8	4.6
	2009	6.8	20.6	140.2	105.0	471.0	31.0	32.0	86.0	30.0	218.0	90.5	110.0	4.2	19.8	146.9	4.3
	2010	8.9	28.0	104.9	93.0	532.0	36.5	33.8	87.0	30.0	222.0	130.2	149.0	10.6	16.4	171.6	4.8
	2011	10.2	32.3	97.4	107.0	518.0	65.5	37.0	97.0	38.0	231.0	136.4	146.0	13.0	19.2	121.7	4.2
	2012	9.3	30.2	97.5	144.0	527.0	31.7	36.9	127.0	41.0	236.0	145.2	150.0	7.2	16.1	101.0	5.2
No. of Author Affiliations																	
	2007	-	-	6	6	26	2	2	1	5	8	1	8	1	5	9	-
	2008	-	-	3	4	29	2	-	3	2	12	6	4	-	5	6	1
	2009	1	-	5	12	14	1	3	2	3	14	5	7	-	2	22	-
	2010	1	-	12	7	25	-	2	3	1	4	3	12	-	-	11	1
	2011	-	-	14	24	27	-	4	8	3	14	6	14	1	-	24	1
	2012	1	-	13	17	33	2	7	10	-	10	3	12	-	2	10	1
No. of Patents																	
	2007	-	-	5	20	56	-	10	11	1	62	2	32	-	-	6	-
	2008	-	-	4	12	89	-	15	5	-	41	5	60	-	3	6	-
	2009	-	1	-	10	93	-	17	15	1	52	4	50	-	1	7	-
	2010	-	-	8	11	115	-	11	10	7	46	-	129	-	2	3	-
	2011	1	1	2	7	87	-	9	13	12	19	4	82	-	1	6	-
	2012	-	1	-	4	43	-	2	6	4	7	-	33	-	1	4	-

Figure 7: Summary of R&D activity areas, 2007-2012, by company (1/2)

		Thermal Process Optimization	Energy Efficiency	General Renewable Energies	Wind Power	Ocean Power	Solar Energy	Biofuel	Nuclear	Decentralized Generation	Smart Grid	E-Mobility	Energy Storage	Carbon Sequestration / CCS	Clean Coal / IGCC	Biodiversity, reduction of nuisances, etc.	Sum
1	**Axpo**																
	2007	1	-	1	1	-	1	1	-	-	-	-	-	1	-	-	6
	2008	1	-	1	1	-	1	1	-	-	-	-	-	1	-	-	6
	2009	1	-	1	1	-	1	1	-	-	-	1	-	1	-	-	7
	2010	1	-	1	1	-	1	1	1	1	1	1	-	1	-	-	10
	2011	1	-	1	1	-	1	1	1	1	1	1	-	1	-	1	11
	2012	1	1	1	1	-	1	1	1	1	1	1	-	1	-	1	12
2	**CEZ**																
	2007	1	-	1	-	-	-	-	1	-	1	1	-	-	-	-	5
	2008	1	-	1	-	-	-	-	1	-	1	1	-	-	-	-	5
	2009	1	-	1	-	-	-	-	1	-	1	1	-	-	1	1	7
	2010	1	-	1	-	-	1	1	1	-	1	1	1	1	1	1	11
	2011	1	-	1	-	-	1	1	1	-	1	1	1	1	1	1	11
	2012	1	-	1	1	-	1	1	1	-	1	1	1	1	1	1	12
3	**Dong**																
	2007	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
	2008	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
	2009	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
	2010	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
	2011	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
	2012	1	1	-	1	-	-	1	-	-	-	1	-	1	-	-	6
4	**E.ON**																
	2007	-	1	-	1	1	-	1	1	1	1	1	-	1	1	1	11
	2008	-	1	-	1	1	-	1	1	1	1	1	1	1	1	1	12
	2009	-	1	-	1	1	1	1	1	1	1	1	1	1	1	1	13
	2010	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	14
	2011	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	14
	2012	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	14
5	**EDF**																
	2007	-	1	1	-	-	-	-	1	-	-	-	1	-	1	1	6
	2008	-	1	1	-	-	-	-	1	-	-	-	1	-	1	1	6
	2009	1	1	1	-	1	1	-	1	1	1	1	1	-	1	1	12
	2010	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	14
	2011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
	2012	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
6	**EDP**																
	2007	1	1	1	-	1	1	-	-	1	1	-	-	-	-	-	7
	2008	1	1	1	-	1	1	-	-	1	1	-	-	-	-	-	7
	2009	1	1	1	1	1	1	-	-	1	1	1	-	1	1	-	11
	2010	1	1	1	1	1	1	-	-	1	1	1	-	1	1	-	11
	2011	1	1	1	1	1	1	-	-	1	1	1	-	1	1	1	12
	2012	1	1	1	1	1	1	1	-	1	1	1	-	1	1	1	13
7	**EnBW**																
	2007	1	1	1	-	-	-	1	1	1	-	-	1	-	-	1	8
	2008	1	1	1	-	-	-	1	1	1	-	-	1	-	-	1	8
	2009	1	1	1	1	-	-	1	1	1	1	1	1	1	-	1	12
	2010	1	1	1	1	-	-	1	1	1	1	1	1	1	-	1	12
	2011	1	1	1	1	-	1	1	1	1	1	1	1	1	-	1	13
	2012	1	1	1	1	-	1	1	1	1	1	1	1	1	-	1	13
8	**Enel**																
	2007	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-	4
	2008	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-	4
	2009	1	1	1	1	-	1	1	-	-	1	1	-	1	-	-	9
	2010	1	1	1	1	-	1	1	-	1	1	1	1	1	-	-	11
	2011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
	2012	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15

Figure 8: Summary of R&D activity areas, 2007–2010, by company (2/2)

		Thermal Process Optimization	Energy Efficiency	General Renewable Energies	Wind Power	Ocean Power	Solar Energy	Biofuel	Nuclear	Decentralized Generation	Smart Grid	E-Mobility	Energy Storage	Carbon Sequestration / CCS	Clean Coal / IGCC	Biodiversity, reduction of nuisances, etc.	Sum
9 **Fortum**																	
	2007	-	-	-	-	1	-	1	1	-	-	1	-	1	-	-	5
	2008	-	-	-	-	1	-	1	1	-	-	1	-	1	-	-	5
	2009	-	-	-	-	1	-	1	1	-	1	1	-	1	-	-	6
	2010	-	-	1	-	1	-	1	1	1	1	1	-	1	-	-	8
	2011	-	-	1	-	1	-	1	1	1	1	1	-	1	-	-	8
	2012	-	-	1	1	1	1	1	1	1	1	1	1	1	-	1	12
10 **GDF_SUEZ**																	
	2007	1	1	1	-	-	-	1	1	-	1	1	1	1	-	-	9
	2008	1	1	1	-	-	-	1	1	-	1	1	1	1	-	-	9
	2009	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	14
	2010	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	14
	2011	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	14
	2012	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	14
11 **Iberdrola**																	
	2007	-	1	1	-	1	1	1	-	-	1	1	-	1	-	-	8
	2008	-	1	1	-	1	1	1	-	-	1	1	-	1	-	-	8
	2009	-	1	1	1	1	1	1	-	-	1	1	1	1	-	-	10
	2010	-	1	1	1	1	1	1	-	-	1	1	1	1	1	-	11
	2011	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	14
	2012	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
12 **RWE**																	
	2007	1	-	-	-	-	-	-	-	-	1	1	-	1	1	-	5
	2008	1	-	-	-	-	-	-	-	-	1	1	-	1	1	-	5
	2009	1	1	-	1	-	1	-	-	-	1	1	1	1	1	-	9
	2010	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	14
	2011	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
	2012	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
13 **SSE**																	
	2007	1	1	1	-	-	-	-	-	-	1	-	-	1	1	-	6
	2008	1	1	1	-	-	-	-	-	-	1	-	-	1	1	-	6
	2009	1	1	1	1	-	-	-	-	-	1	-	1	1	1	-	8
	2010	1	1	1	1	-	-	-	-	-	1	-	1	1	1	1	9
	2011	1	1	1	1	-	-	-	-	-	1	-	1	1	1	1	9
	2012	1	1	1	1	-	-	-	-	-	1	-	1	1	1	1	9
14 **Statkraft**																	
	2007	-	1	1	1	1	1	-	-	-	-	-	-	-	-	1	6
	2008	-	1	1	1	1	1	-	-	-	-	-	-	-	-	1	6
	2009	-	1	1	1	1	1	-	-	-	-	-	-	-	-	1	6
	2010	-	1	1	1	1	1	-	-	-	-	-	-	1	-	1	7
	2011	1	1	1	1	-	-	1	-	1	1	-	-	1	-	1	9
	2012	1	1	1	1	-	-	1	-	1	1	-	1	-	-	1	9
15 **Vattenfall**																	
	2007	1	1	1	1	1	1	1	-	-	1	-	-	1	-	1	10
	2008	1	1	1	1	1	1	1	-	-	1	-	-	1	-	1	10
	2009	1	1	1	1	1	1	1	1	1	1	1	-	1	-	1	13
	2010	1	1	1	1	1	1	1	1	1	1	1	-	1	-	1	13
	2011	1	1	1	1	1	1	1	1	1	1	1	-	1	-	1	13
	2012	1	1	1	1	1	1	1	1	1	1	1	-	1	-	1	13
16 **Verbund**																	
	2007	1	1	1	-	-	1	-	-	-	-	-	-	-	-	1	5
	2008	1	1	1	-	-	1	-	-	-	-	-	-	-	-	1	5
	2009	1	1	1	1	-	1	-	-	1	1	1	1	-	-	1	10
	2010	1	1	1	1	-	1	-	-	1	1	1	1	-	-	1	10
	2011	1	1	1	1	-	1	-	-	1	1	1	1	-	-	1	10
	2012	1	1	1	1	-	1	-	-	1	1	1	1	-	-	1	10

Appendix 2: Notes on data and methodology

The ESMT Innovation Index is based on publicly available data, in particular annual reports as well as sustainability reports of the 16 companies for the years 2007 to 2012.[7] Data tables were sent to all companies to receive feedback, in particular with respect to activities in different research areas.

We applied the ESMT Innovation Index to European electricity incumbents, in total 16 companies from the following countries and/or regions:

- *Central Europe*: Verbund and CEZ
- *France and Belgium*: Electricité de France (EDF) and GDF-Suez
- *Germany*: EnBW, E.ON and RWE
- *Italy*: Enel
- *Scandinavia*: Dong, Fortum, Statkraft and Vattenfall
- *Iberian Peninsula*: Iberdrola and Energias de Portugal (EDP)
- *Switzerland*: Axpo
- *United Kingdom*: Scottish and Southern Energy (SSE)

The selection of companies is motivated by the fact that they occupy an incumbent position in their domestic electricity market. Niche players are excluded. One major condition to enter the sample is that they are not mere subsidiaries of (another) multinational company, but have their own research and development strategy. The only addition to the sample since the first release of the ESMT Innovation Index in 2011 is EnBW, which became fully independent from EDF again in 2010.

Figure 9 on the following page shows the individual companies in the sample and their respective annual power generation.

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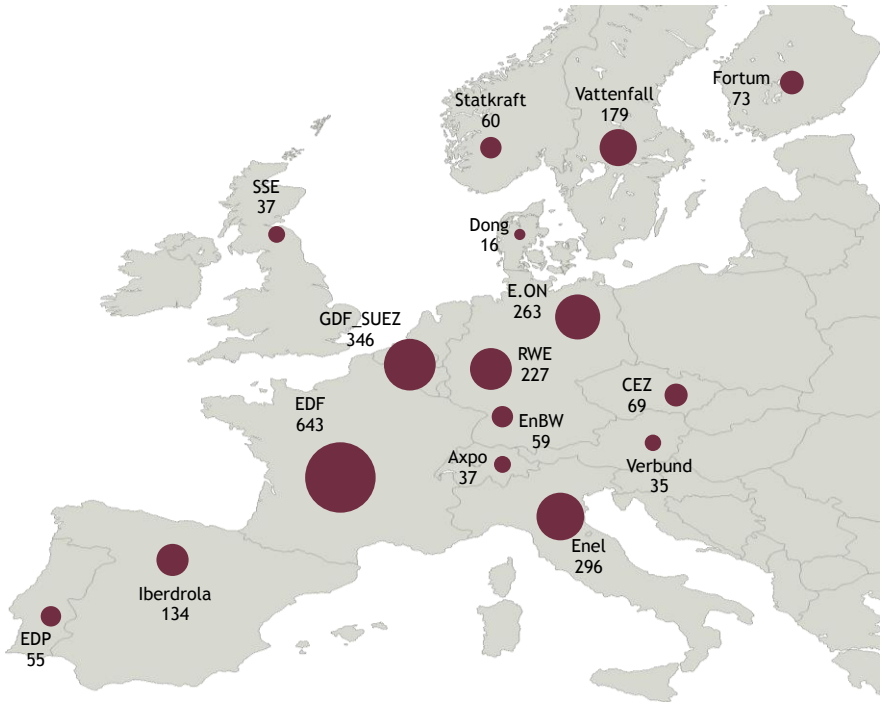
[7] Of the 16 companies, Axpo and SSE do not have a January to December reporting financial period. For example, the financial period of SSE ends on March 31. We have recorded the entries of its latest, i.e., 2011/12 annual report under 2011, since 9 out of the 12 months are in 2011. Please see appendix 4 for further details.

Figure 9: Companies covered in the ESMT Innovation Index and their respective annual electricity generation (in TWh)



Note: Bubble size proportional to total annual power generation (TWh), which is shown below the company name. Location of companies is only meant to be indicative of the country they are headquartered in.

Source: ESMT analysis (2013).

To specifically operationalize and adapt Schumpeter's categories of innovation to the electricity supply industry, we used valuable inputs from industry, academia, and consulting to identify 3 distinct attributes of innovation activities within an organization:

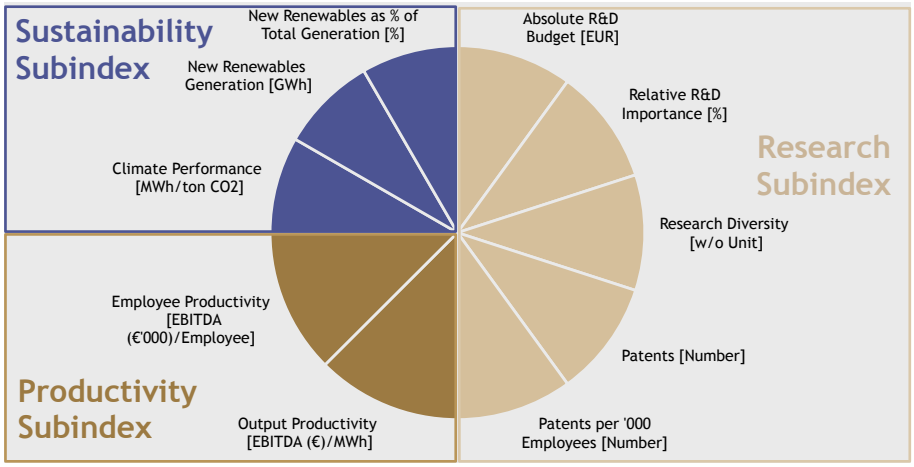
- The **Research Subindex** monitors the importance, efforts and diversity of R&D undertaken by electricity utilities. It includes 5 indicators: (1) absolute R&D budget, (2) relative R&D importance as measured by the ratio of the overall R&D budget to EBITDA, (3) research diversity, (4) number of patents, and (5) number of patents per thousand employees. A difference to the composition of the ESMT Innovation Index 2010 is the fifth indicator, which did not exist in the previous release. We decided to integrate it at the request of smaller utilities, because they argued that utilities with a smaller workforce would be in a structural disadvantage if only the absolute number of patents were taken into account.

- The **Sustainability Subindex** evaluates efforts to integrate new and environmentally sound sources of energy and to minimize CO_2 emissions. It consists of 3 indicators: (1) climate performance, as measured by the company's specific carbon dioxide emissions in MWh per ton of CO2, (2) "new" (i.e., non-hydro) renewable electricity generation in GWh, and (3) "new" renewable electricity generation as a percentage of total generation (in percent). Similar to the addition in the Research Subindex, the last indicator was integrated to account for differences in size of utilities.
- The **Productivity Subindex** measures the operative and sales performance of the companies: (1) output productivity in EBITDA per energy output (€/MWh), and (2) employee productivity in EBITDA per employee.

Among those 3 categories, 50 percent of the weight is given to the Research Subindex, thereby valuing efforts to improve the innovation position of a company and enhancing its long-term prospects as a market leader. The remaining 50 percent are allocated in equal terms to the Sustainability and Productivity Subindices, which represent efforts to environmentally and economically optimize processes within the firm.

Figure 10 shows the relative contribution of each of the factors to the overall score.

Figure 10: Composition of the ESMT Innovation Index – Electricity Supply Industry



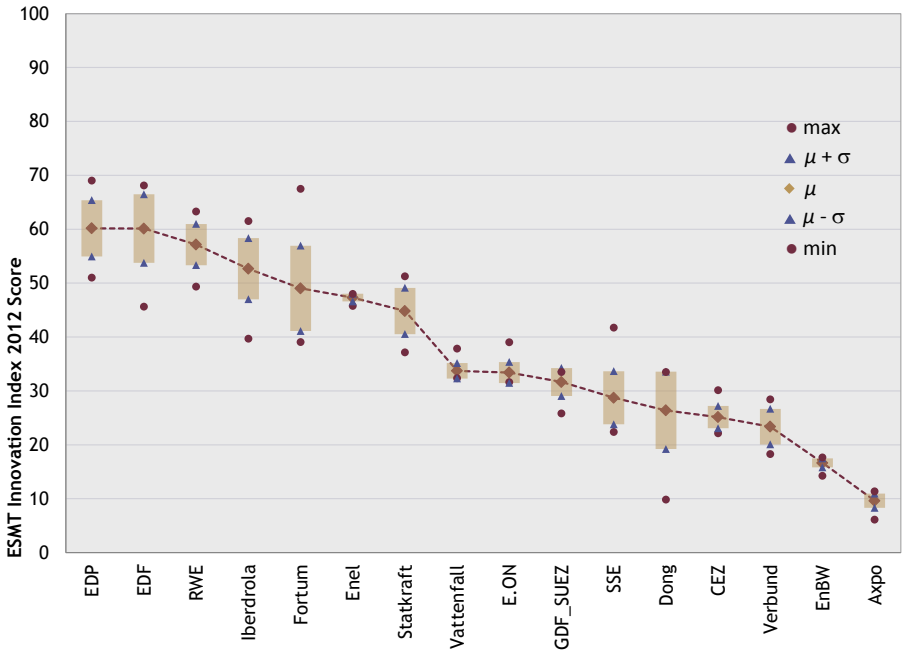
For the composition of the overall index, the individual indicators are normalized. To account for the dynamics of the transformation, each criterion is measured based on the current status (stock) and the changes that occurred during the sample period (flows). More recent changes have a greater weight than past efforts. Further details on the methodology for the computation and the justification of input variables can be found in the first release of the ESMT Innovation Index (Burger and Weinmann, 2012).

To test the overall robustness of the index and the effects of different weightings on the index scores, the weights allocated to the Research Subindex (currently 50%) were varied between 40 percent and 60 percent. The balance weight was split equally (30%/30% and 20%/20% respectively) between the Productivity and Sustainability Subindices.

Simultaneously, the weight allocated to the data parameters from the most recent year (currently 75%) was varied between 60 percent and 80 percent. The changes over the preceding period, that is, from inception of the ESMT Innovation Index to the second most recent year, correspondingly received weightages varying between 40 percent and 20 percent.

The results of this two-way sensitivity analysis are shown in figure 11 below. For each company in the sample, the graph shows the current index value, the bandwidth of the current value plus/minus one standard deviation, as well as the maximum and minimum values according to this sensitivity.

Figure 11: Sensitivity of the ESMT Innovation Index 2012 values to simultaneously changing weightages of Research Subindex and stock/flow variables



Source: ESMT analysis (2013).

The results indicate that changing the weightage scheme does not substantially alter the ranking among the leading companies, and has little impact on the remainder of the sample.

A further sensitivity analysis was undertaken to compare the results of the ESMT Innovation Index 2012 with the scores companies would have achieved using the input variables of the ESMT Innovation Index 2010. Again, the results differed only marginally.

Which utilities have been able to improve or maintain their ranking in the 3 Subindices since the last release of ESMT Innovation Index? How has their overall rank in the ESMT Innovation Index changed?

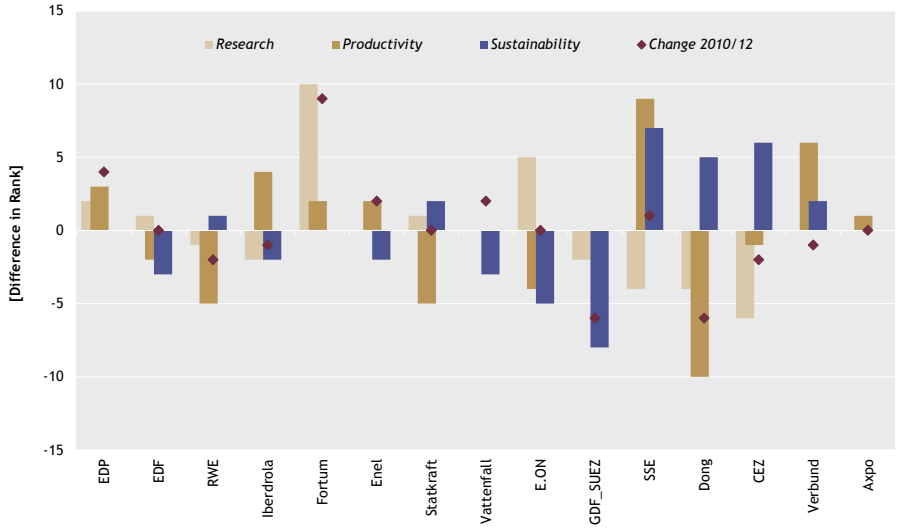
An analysis of each company's performance[8] in the 3 Subindices as well as the overall ranking shows that between 2010 and 2012 Fortum and EDP have been able

[8] EnBW has not been integrated in the comparison, because it was not part of the sample in 2010.

to significantly improve their overall ranking, whereas Dong and GDF-Suez have experienced the strongest decline.

Figure 12 shows the changes in the overall ranking of the ESMT Innovation Index since 2012 as well as the changes in 3 Subindices.

Figure 12: Changes in the ranking of the ESMT Innovation Index between 2010 and 2012



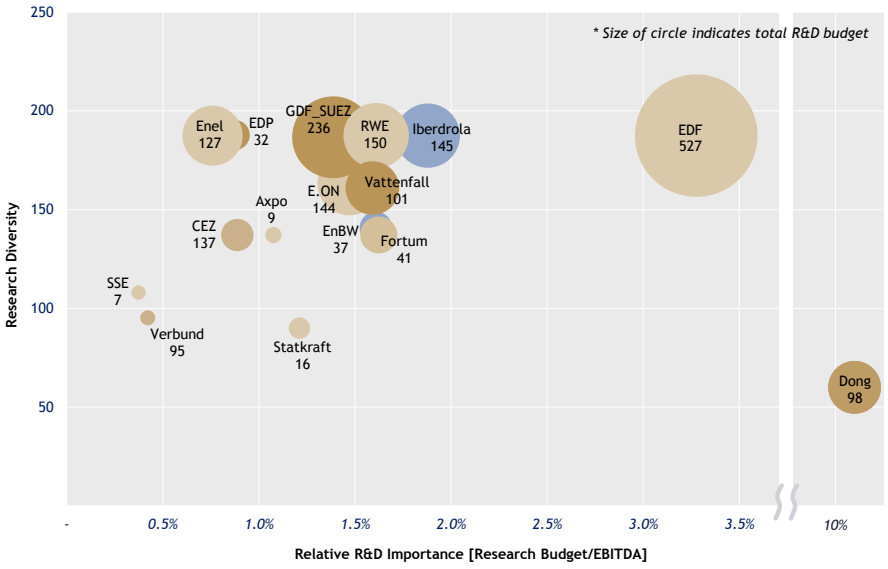
Source: ESMT analysis (2013).

Appendix 3: Graphs on indicators and investments

For representatives of the utilities, investors and scholars it may be of interest to graphically compare the performance of the sample's companies. In addition to 3 graphs that capture the most important indicators of each Subindex, we also provide an overall comparison of the ESMT Innovation Index 2012 with the investments that each utility undertook in 2012 (whereby M&A activities are not included in the investment level).

The following graph depicts relative R&D importance on the horizontal axis, research diversity on the vertical axis, whereas the size of each observation's circle indicates the absolute R&D importance, that is, the total R&D budget.

Figure 13: Research diversity vs. relative R&D importance (2012)

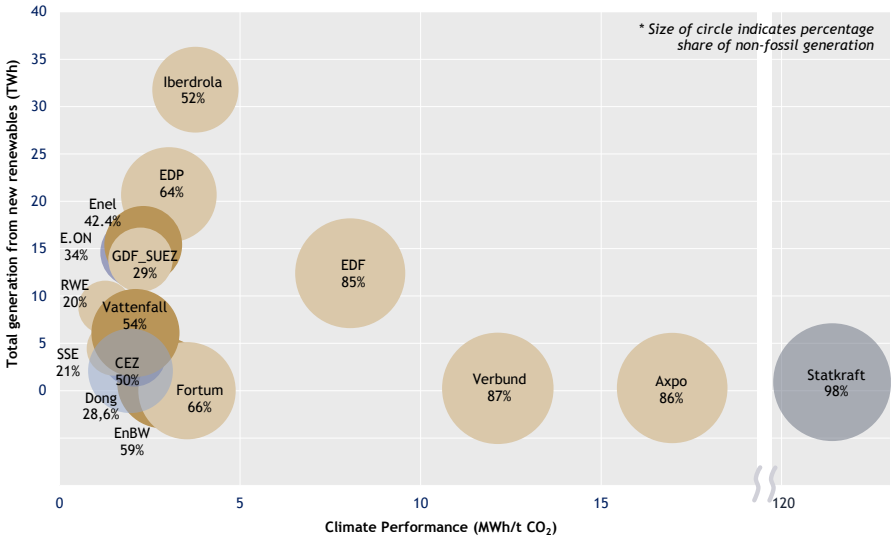


Note: Differences in the color scheme are only for visual distinction of the observations.

Source: ESMT analysis (2013).

In figure 14, climate performance (i.e., energy produced per ton of carbon dioxide) is depicted on the horizontal axis, while the total electricity generation from "new" renewable energy sources is shown on the vertical axis. As a benchmark (but not explicitly integrated in the subindex), the share of non-fossil generation is indicated by the size of the circles.

Figure 14: Climate performance vs. "new" renewable generation (2012)

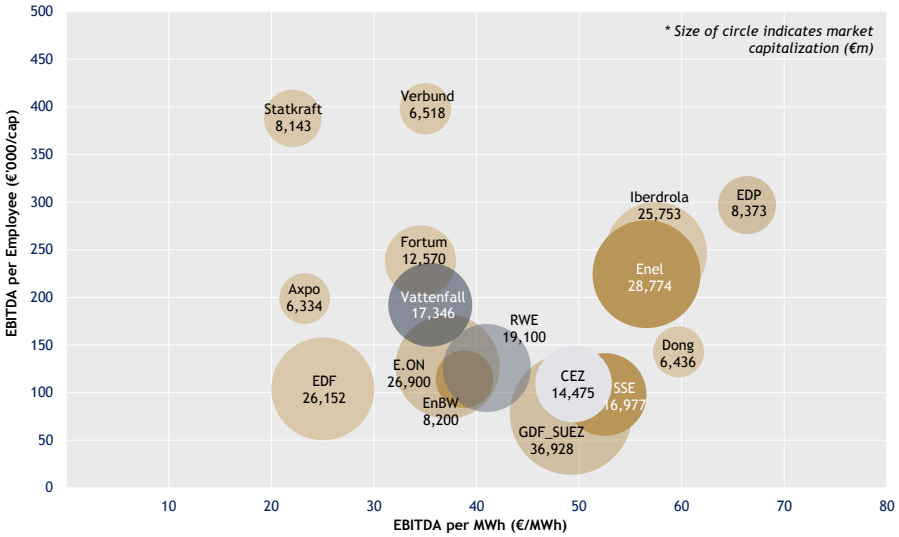


Note: Differences in the color scheme are only for visual distinction of the observations.

Source: ESMT analysis (2013).

Figure 15 depicts the input variables used to measure each company's performance in the Productivity Subindex. Output productivity, that is, earnings per generated electricity, is shown on the horizontal axis, and employee productivity, with earnings per employee as its proxy, is shown on the vertical axis. The size of the circles depicts the total market capitalization of a company as of the end of 2012.[9]

Figure 15: Employee productivity vs. output productivity (2012)



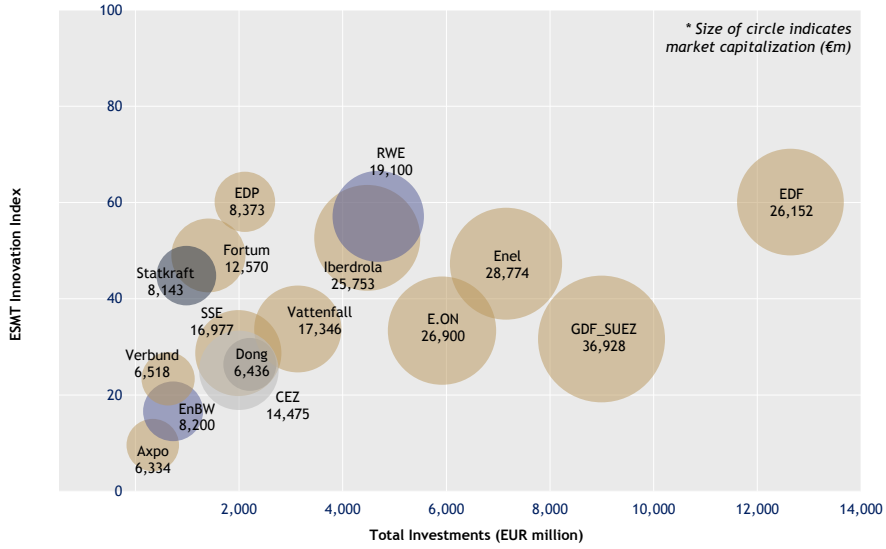
Note: Differences in the color scheme are only for visual distinction of the observations.

Source: ESMT analysis (2013).

[9] In the case of companies that are not publicly listed, market capitalization has been estimated based on book values of equity and price to book value ratios (Market Cap = BV of Equity x PBV); PBV ratios have been taken from Aswath Damodaran's EuroCompFirm database (www.damodaran.com).

The following graph plots the scores of the ESMT Innovation Index 2012 on the vertical axis against investment in intangible assets, property, plant and equipment as a percentage of earnings (EBITDA). The size of the circles indicates the total amount of the investments.

Figure 16: ESMT Innovation Index 2012 and investments



Source: ESMT analysis (2013).

Note: Differences in the color scheme are only for visual distinction of the observations.

Appendix 4: Key assumptions

1. **Information sources**: Input data of the companies is primarily based on the information provided in the respective published documents like the annual report and sustainability report. Other sources used (e.g., for patents) are mentioned below.
2. **Patents**: Information on the number of patents has been gathered from the information databases of sources like the German Patent and Trade Mark Office (DPMA) and the European Patent Office (EPO).
3. **Superiority of updated information**: For any given parameter, the information has been treated as superior if it was available in a more recent or updated publication than in the original one. Companies in our sample have made retrospective adjustments to figures previously published in their own annual reports, so wherever available and possible, we have used the latest published figures for any given parameter. For example, if a company, in its 2012 Annual Report, has reported (retrospectively) adjusted figures for, say, its own EBITDA in the previous year 2011, then the EBITDA figures reported in the 2012 Annual Report have been used in our calculations, as we have treated these figures as superior to the EBITDA figures reported originally in the 2011 Annual report.
4. **Superiority of non-adjusted figures over proforma ones**: To the extent possible, for any given input parameter, we have used figures that are better comparable across all companies than *proforma* figures which a company may have reported after making certain adjustments. For example:
   (i) E.ON (Adjusted) EBITDA: Instead of EBITDA, E.ON has reported *Adjusted* EBITDA, that is, EBITDA after making adjustments for one-time and extraordinary items. To make the comparison like for like with other companies, we have used figures for a comparable entry in E.ON's income statements: income/loss from continuing operations before financial results and income taxes.
   (ii) RWE R&D expenses: The R&D figures that we have used for RWE only include the R&D expenses for that year. They *exclude* capitalized development costs (which are approximately as high as the R&D costs) and are disclosed alongside the R&D expenses.
5. **Reporting period**: The reporting period is considered on a "last 12 months" (LTM) basis rather than on the calendar year basis (January through December). For example, Axpo's financial year ends on

September 30 each year. The latest annual report is for the period October 1, 2011, through September 30, 2012. Since the majority (9 of 12 months) of this period falls in 2012, the figures from this Annual Report have been captured under the year 2012 in our calculations. No interpolations or extrapolations for fractional parts of years have been made.

6. **Currency conversions**: Monetary amounts have been converted from local currency and have ultimately been expressed in Euro (€ or EUR). Conversions for (flow) variables like EBITDA are based on the average exchange rate for the respective 12-month reporting period under consideration. Conversions for (stock) variables like market capitalization are based on the spot exchange rate on the last day of the reporting period. Historical exchange rates have been taken from the currency converter of the "O and A" website: http://www.oanda.com/currency/historical-rates/.

7. **Electricity generation**: Companies report their electricity output, that is, total electricity produced/generated in MWh/GWh/TWh etc., as *full* data or *share* data – at times providing both figures. Full data refers to the total production from 100 percent of the capacities of the assets controlled by the company, irrespective of what the actual holding may be. Share data refers to the production after taking account of the actual holding. We have used those figures

   (i) which the companies consistently reported in their publications, and

   (ii) for which we could obtain the requisite breakup data, say for generation according to fuel type. For example, GDF-Suez reported full and share data in 2008 and 2010. We have used full data, based on the reasoning just mentioned.

Appendix 5: References

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Authors

Christoph Burger is lecturer at ESMT European School of Management and Technology and managing director of ESMT Customized Solutions GmbH.

Jens Weinmann is program director of the practice group TTU at ESMT Customized Solutions GmbH.

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ESMT European School of Management and Technology was founded in October 2002 by 25 leading global companies and institutions. The international business school offers Full-time MBA and Executive MBA programs, as well as executive education in the form of open enrollment and customized programs. The business school works closely together with E.CA Economics, which provides research-oriented consulting services in the areas of competition and regulation. ESMT is a state-accredited private business school based in Berlin, Germany, with an additional location in Schloss Gracht near Cologne.

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ESMT
European School of Management and Technology
Faculty Publications
Schlossplatz 1
10178 Berlin
Germany

Phone: +49 30 21231-1279
publications@esmt.org
www.esmt.org