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Creation and Adoption of Energy-related Innovations – the Main Facts*

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1 Introduction and main descriptive results

One of the main goals of the "Energy Strategy 2050" in Switzerland is the exploitation of the existing energy efficiency potentials. The size of the efficiency potential strongly depends on the development and the adoption of energy-related innovations. The objective of this project is to improve our knowledge about the drivers and potentials of both the adoption and the creation of energy-saving technologies and other technologies for the generation of renewable energy sources through a comparative firm-level study for Switzerland, Germany and Austria.[1] Firms are not only the main source of energy-related innovation, but they are also responsible for a considerable share of the total energy consumption.

The data presented here has been collected through firm surveys conducted in all three countries at the same time. The surveys used a harmonized questionnaire and collected information both on the *development* and on the *adoption* of energy-related innovations during the years 2012 to 2014. While data on the *adoption* of energy-related technologies has been obtained for all major economic sectors (manufacturing, construction and services, excluding state-related services such as public administration, education and health and excluding the energy sector) data on the *development* of energy-related innovations has only been collected for a group of manufacturing sectors (excluding food, textiles and clothing, printing, pharmaceuticals, and "other manufacturing") as well as two service sectors, "information technology services" and "technical services".

All data are weighted according to the scheme described in Appendix 3 in order to be representative for the firm population of each of the three countries.

We consider the following findings as particular noticeable:

- Relatively low shares of firms using *renewable energy sources* (not from external providers) (15% to 23% depending on country);
- Considerable shares of firms *adopting energy-related technologies* (25% to 41% depending on country);
- High importance of energy-related *building technologies* (56% to 69% of adopting firms depending on country);
- Relatively high assessment of the *effectiveness* of the use of energy-related technologies with respect to:
    - the reduction of *energy consumption* (59% to 75% of adopting firms depending on country);
    - the reduction of *CO2 emissions* (40% to 53% of adopting firms depending on country);
- Relatively low importance of *adoption obstacles* (for most obstacles less than 20% of all firms reported some relevance);

[1] In what follows we use the term energy-related technologies for these types of technologies. This publication is part of and funded by the NRP 71 (Managing Energy Consumption) project. The funded project has the title "Creation and Adoption of Energy-Related Innovations" (407140L_153901/2).

- Relatively low importance of *innovation obstacles* (for most obstacles less than 20% of all firms reported some relevance);
- Dominant role of energy-related innovation in the industries for *vehicles, machinery and electrical machinery;*
- Relatively low relevance of a series of *energy-related factors* such as energy prices, regulations, taxes and public promotion in form of subsidies (1% to 12% depending on factor/policy and country), with the exception of energy prices for Germany and energy taxes for Germany and Austria;

2 Energy costs and energy consumption

Table 2.1 shows the average energy ratio (measured by energy costs as sales share) by sector and by firm size (three size classes) as well as for the entire economy for the three countries in 2014.[2] The Austrian firms report the highest energy ratio in manufacturing and services, the difference to the two other countries being largest in the services sector, which is most affected by difficulties that arise from the smaller overall sample. The respective figures for Germany and Switzerland lie quite close, Switzerland showing a slightly higher intensity for the entire economy (1.4% versus 1.3% for Germany; Austria: 2.7%). In Germany and Switzerland the energy ratio is almost equal for manufacturing and construction, but quite different in the service sector. In all three countries is the energy ratio in manufacturing higher than in the service sector. No common regularities are found with respect to small firms (5-49 employees), medium-sized firms (50-249 employees), and large firms (>=250 employees).

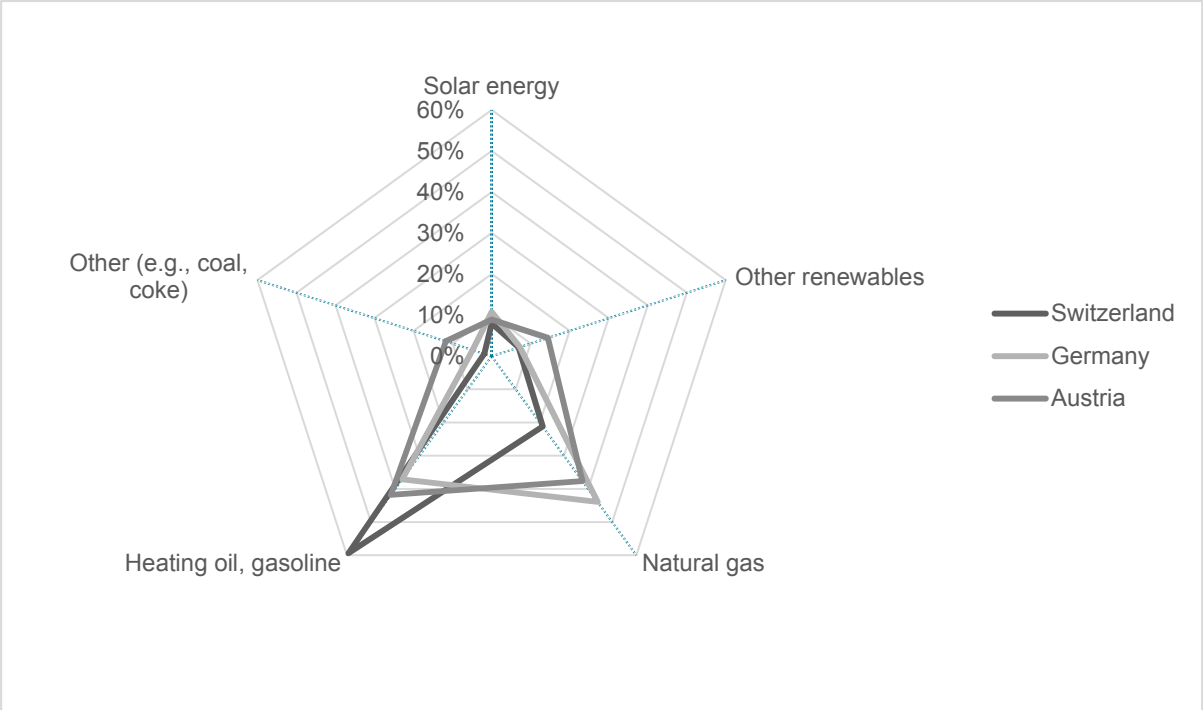
Table 2.1: Energy costs as share of sales in %

	Switzerland	Germany	Austria
Manufacturing	2.1	2.3	3.2
Construction	2.0	1.9	1.7
Services	1.2	0.7	2.5
Small	1.6	1.5	4.5
Medium	0.9	1.8	1.7
Gross	1.8	1.0	2.9
Total	1.4	1.3	2.7

In all three countries, electricity from external providers is the most frequently used energy source, namely for 96% to 98% of all firms. The second most frequently used energy source in Switzerland (59% of firms) and in Austria (42%) is gasoline / fuel oil while in Germany it is natural gas (44%) (Figure 2.1 without electricity). Solar energy is much less frequently used in all three countries (8% to 11%), other renewable energy sources are used only by a small share firms (7% to 14%).

[2] The energy ratio was calculated by weighting the firm-specific energy ratio with the firm's share in total sales in the stratum a firm belongs to. "Small", "medium", "large" refers to firms with 5-49 employees, 50-249 employees, and 250+ employees, respectively.

Figure 2.1: Use of energy sources (% of firms)



3 Adoption of energy-related technologies

3.1 Fraction of adopters

The share of firms that adopted at least one energy saving technology or generated for the first time renewable energy sources in the reference period 2012-2014 is at highest in Germany (40%), followed by Austria (32%) and Switzerland (25%) (Figure 3.1). In Switzerland the propensity to adopt energy-related technologies is rather equally distributed among the sectors of the economy (21% to 33% of firms). In the other two countries the adoption propensity is distinctly stronger in manufacturing than in the service sector.[3] In all three countries the share of adopting firms depends on firm size, with larger firms reporting the adoption of energy-relevant technologies more frequently than smaller firms.

A more detailed analysis by industry is shown in Table A.1 in the Appendix 1. A common feature is that on average significantly more firms adopt energy-related technologies in manufacturing than in the service sector in all three countries, presumably due to the higher energy intensity of manufacturing as compared to services. The pattern of adoption at industry level is quite different among the three countries. In Switzerland the propensity of adoption is more equally distributed among industries than in the other two countries. In manufacturing basic metals (54%) and plastics (44%) are the industries with the highest share of adopting firms, publishing/media (53%) and personal services (40%) in the service sector. In Germany the industries for vehicles (69%), other manufacturing (61%) and paper

[3] The extraordinarily high percentage of Austrian adopters in construction can be explained by the smaller sample for this sector.

and plastics (both 61%) show the highest adoption propensity in manufacturing. In the service sector the highest shares are reported by whole trade (50%) and telecommunication (44%). In Austria the highest shares of adopting firms are found in electronic and optical products (97%), metals (89%) and other manufacturing (80%). Tourism industry (96%) and wholesale trade are the service industries with the highest adoption propensity.

Figure 3.1: Share of adopting firms (in % of firms)

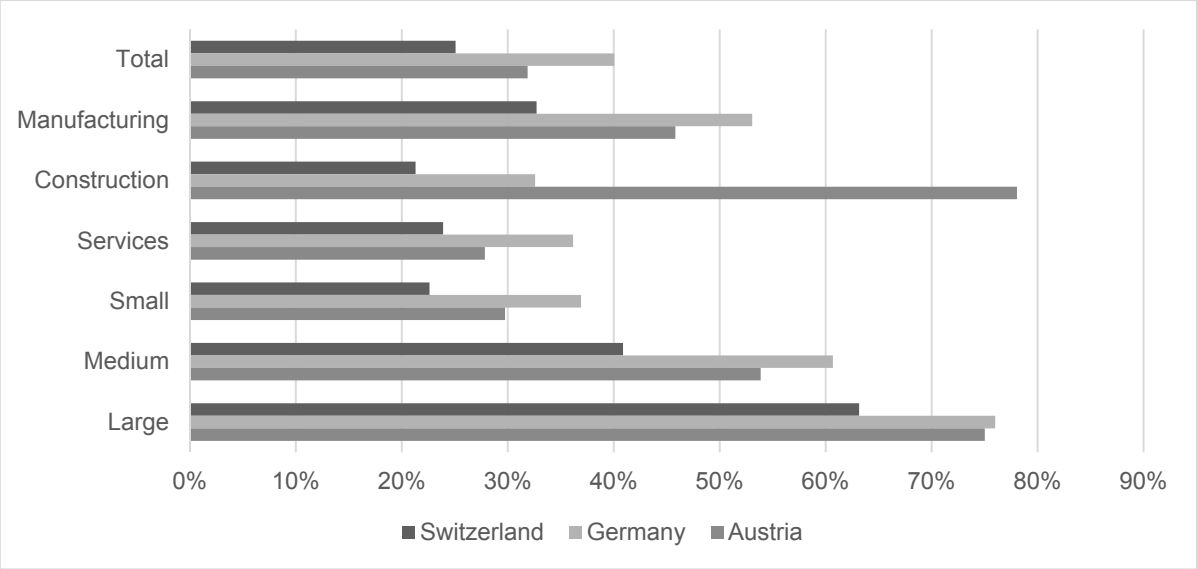
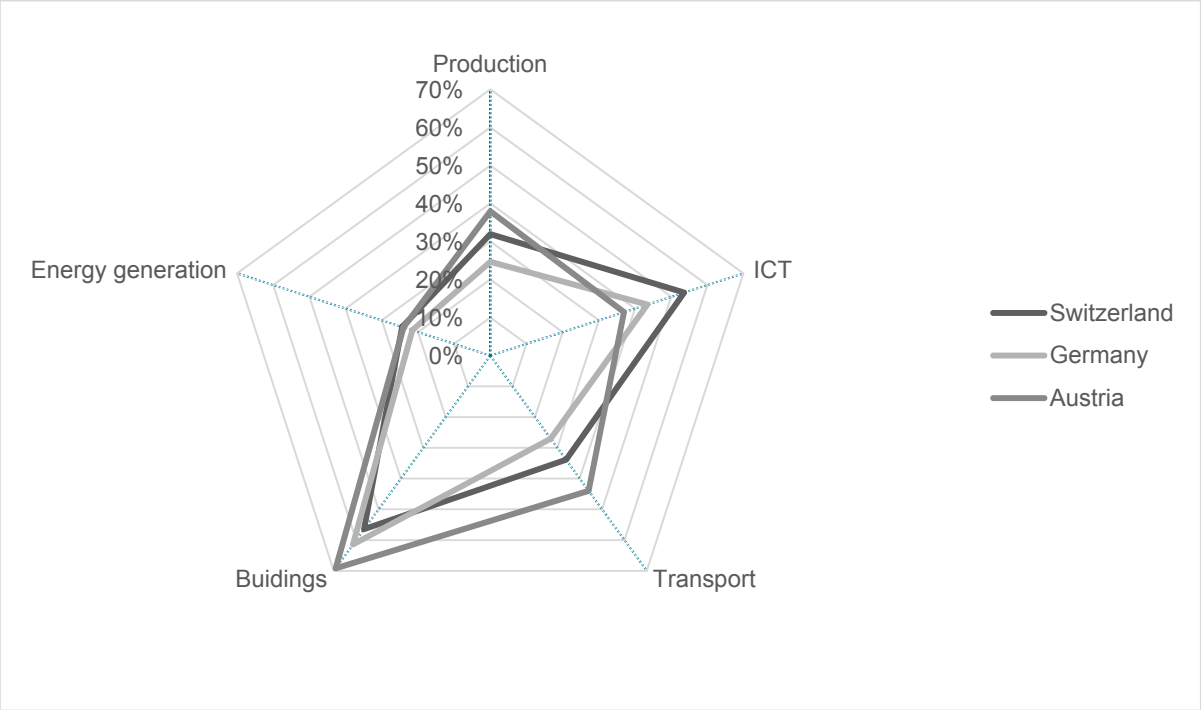


Figure 3.2: Share of adopting firms by field of technology (in % of adopting firms)



The questionnaire distinguished five categories of energy-related technologies that could be adopted by firms: (a) technologies that are related to production (e.g., energy-saving machines, gears); (b) technologies related to ICT (e.g., energy-saving servers); (c) technologies related to transport vehicles (e.g., energy-saving automobile motors); (d) energy-saving building technologies (e.g., isolation and

ventilation technologies); and (e) technologies for the generation of renewable energy sources (e.g., solar energy).

Figure 3.2 contains information about the propensity of adopting firms (i.e. share of adopting firms) with regard to certain types of energy-related technologies. In all three countries firms give more emphasis to building technologies (51% to 69% of firms) than to other technologies. On average of all three countries, second most frequently named are ICT technologies (37% to 54%), followed with some distance by transport-related technologies (27% to 44%), production-related technologies (25% to 38%), and generation of renewable energy sources (22% to 24%).

3.2 Adoption of certified energy-relevant management systems

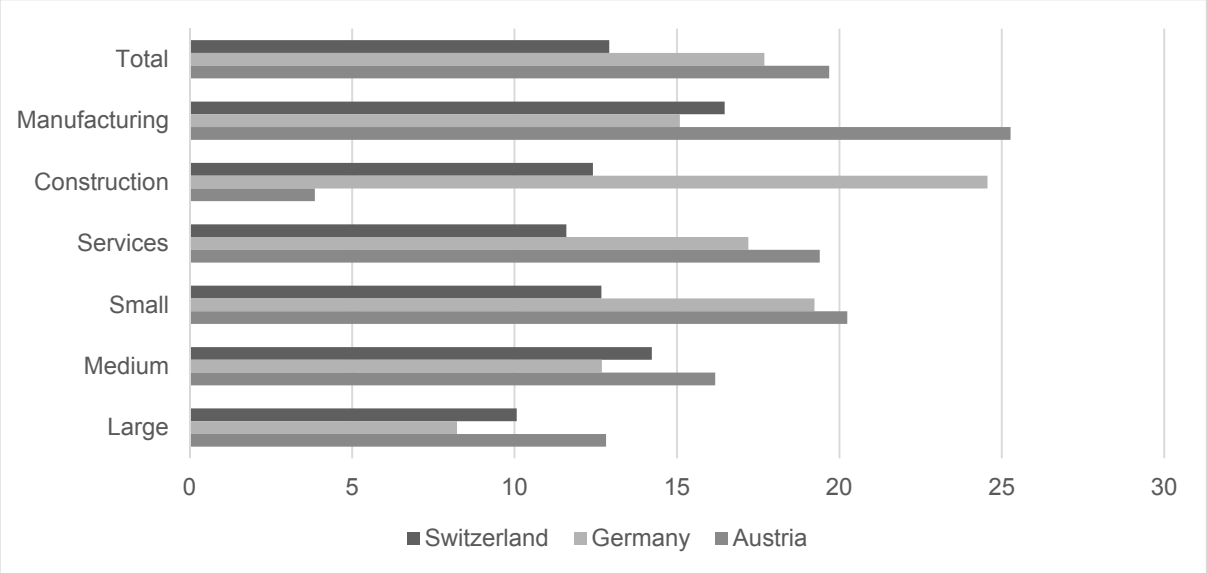
Certified energy-related management systems (e.g., environment certifications in accordance to ISO 140001, energy management in accordance to ISO 50001, standardized environment or energy reports) are used to monitor energy consumption or other environment-relevant effects.

Energy-related management systems are used in only 12% of the firms of all three countries (see Table A.2 in Appendix 1). The respective figure for Switzerland is 17%, for Germany 11% and for Austria 13%. Primarily manufacturing firms adopt such management systems, e.g., 57% of all firms in metal producing industry, 37% in chemical industry, but only 1% to 13% in most service industries. The more detailed analysis by industry in Table A.2 in Appendix 1 shows that in all three countries manufacturing firms report the use of management systems more frequently than service firms. The highest shares of firms adopting management systems are found commonly in all three countries in the paper and in the metal industry (44% to 70% depending on country and industry). In Switzerland the environment/water industry shows a strong above-average propensity for management systems, in Austria the industry of electronic and optical products.

3.3 Investment share for the adoption

In 2014 investment in energy-related technologies on average of all firms amounted to 12.9% of total gross investment expenditures in Switzerland, to 17.7% in Germany, and to 19.7% in Austria (Figure 3.3). Switzerland has the lowest adoption propensity and shows the lowest share of energy-related investment expenditures among the three countries. The Austrian firms report on average the highest investment share, even if their adoption propensity is lower than in Germany. In Austria and in Switzerland the investment share is higher in manufacturing then in the service sector, contrary to Germany, where this share is higher in services.[4] In all three countries large firms invest a smaller part of their total investment in energy-related technologies than medium-sized and small firms.

Figure 3.3: Share of investment for technology adoption (in % of total investments)



3.4 Impact of adoption on the environment

Our questionnaire distinguishes two possible impacts of the adoption of energy-related, particularly, energy-saving technologies that could be favorable for the environment: (a) reduction of energy consumption and (b) reduction of CO_2-emissions.

Figure 3.4 and Figure 3.5 show the firm assessments for these two types of possible impacts. The answers are quite heterogeneous in the three countries. 75% of the Austrian firms report “some reduction” or “significant reduction” of energy consumption as a result of the adoption of energy-saving technologies, the respective figures for Switzerland (67%) and Germany (59%) are distinctly lower. However, 53% of Swiss firms report “significant reduction” of energy consumption, the respective figures for the other two countries are much lower (18% and 21%, respectively). The impact of adoption seems to be stronger in Switzerland than in the other two countries. With respect to CO_2-emissions 53% of Austrian firms and 51% of Swiss firms report “some reduction” or “significant reduction” of CO2-emissions, significantly more than in Germany (40%). Also in this case Swiss firms seem to be more effective, 42% of them report “significant reduction” of emissions as compared with 13% in Ger-

[4] The extraordinarily low share of energy-related investment of Austrian firms in construction can be explained by the low availability of firm data for this sector in the sample used in this study.

many and 19% in Austria. However, it has to be taken into account that many more Austrian and particularly German firms refrained from assessing the impacts of technology adoption as compared with firms in Switzerland.

Figure 3.4: Impact of technology adoption on energy consumption

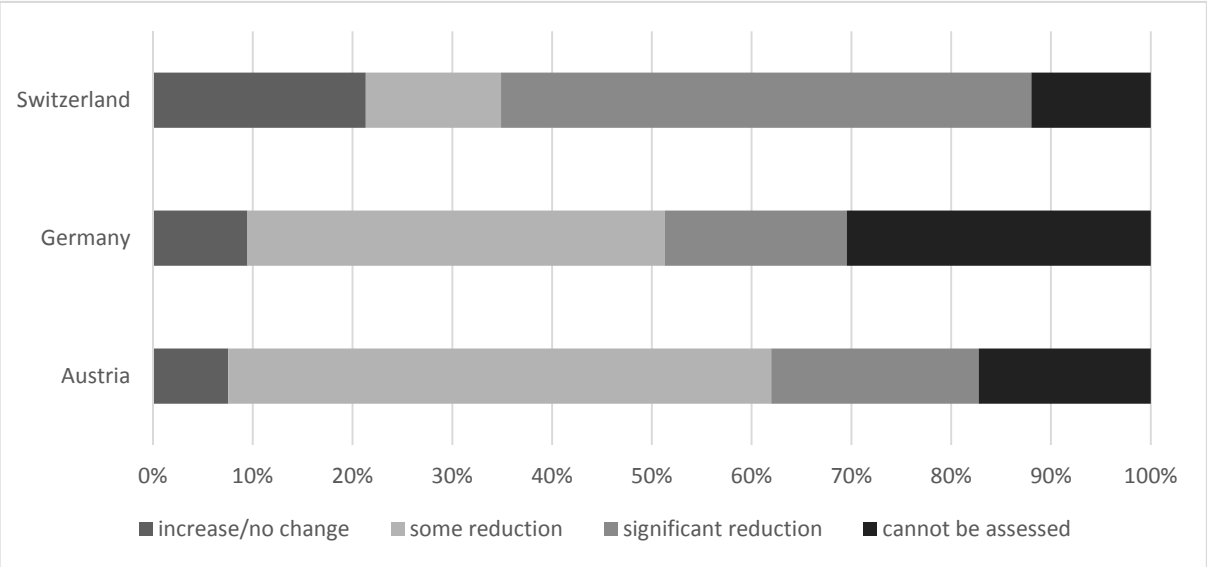
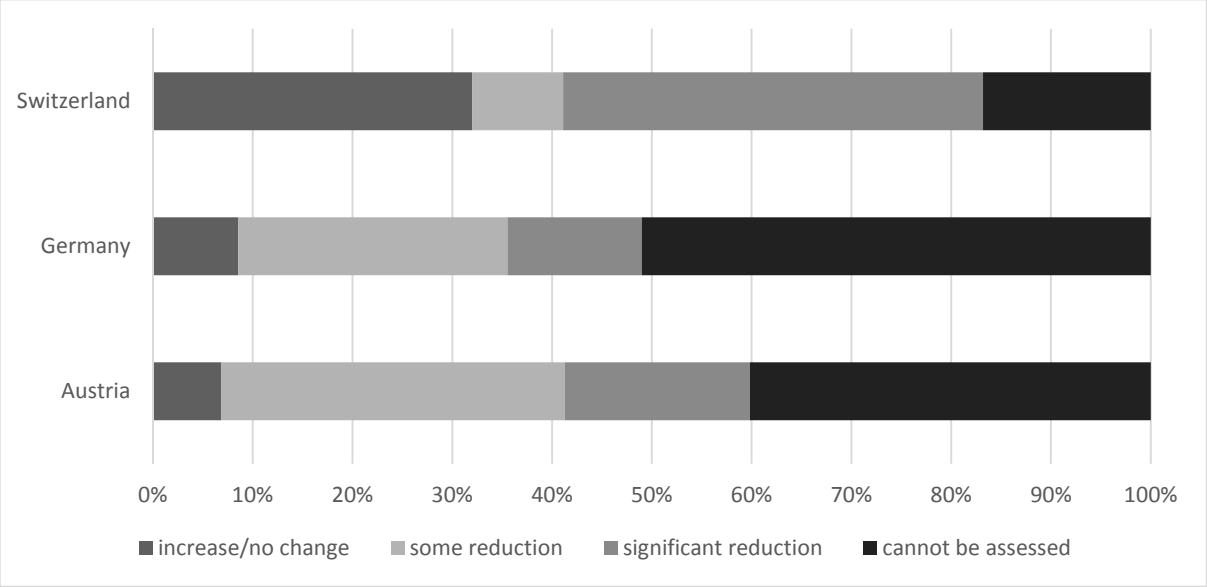


Figure 3.5: Impact of technology adoption on CO_2-emission

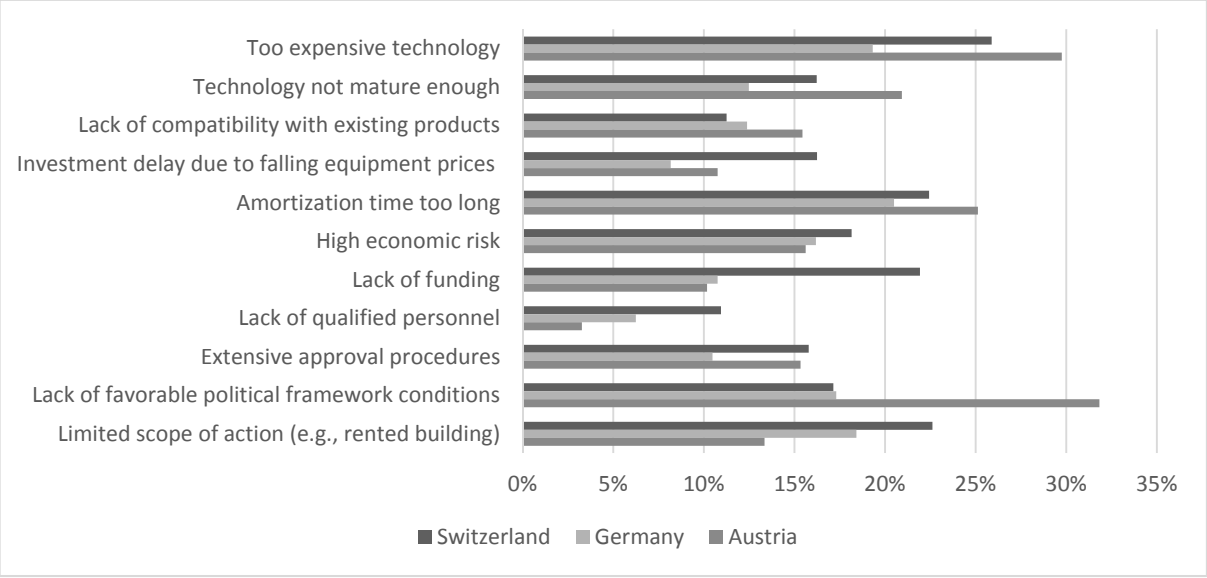


3.5 Obstacles for adopting energy-related technologies

Our questionnaire distinguishes 11 possible obstacles for the adoption of energy-related technologies covering all possible factors that could hamper the introduction of energy technologies. Six of them ("technologies are too expensive"; "technologies are not fully developed"; "technologies are not compatible with product program"; "technology prices are falling"; "economic risk is too high"; "amortization time of the investment is too long") refer directly to the energy technologies that could be adopted. Two further obstacles refer to lack of resources (finances and personnel). Two obstacles cover administrative and political hindrances and one is related with the possibility that firms may have only limited room for deciding for such an adoption due, e.g., to the fact that they do not own the building they use.

The obstacles are measured on a four-point Likert scale. Figure 3.6 presents the percentage of firms that report on the two upper levels "high relevance" or "very high relevance" of a certain obstacle. The most frequently reported obstacle on the average of all three countries is "technologies are too expensive", followed by "amortization time of the investment is too long" and "limited room of deciding for such an adoption". The responses are relatively equally distributed across countries as well as across obstacle categories. It is noticeable that Swiss firms assess lack of finances and personnel as relevant obstacles more frequently than firms in the other two countries. Insufficient political promotion is considered a particularly relevant hindrance among Austrian firms.

Figure 3.6: Obstacles of adoption (% of firms reporting at least "some relevance")



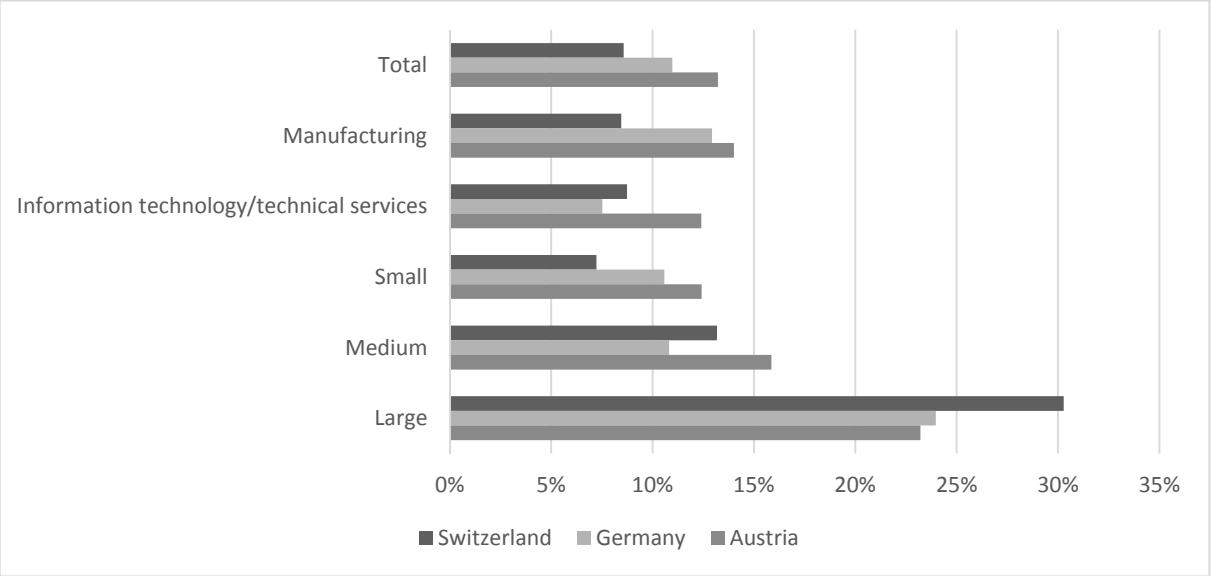
4 Development of energy-related technologies and market introduction

4.1 Fraction of firms that generated energy-related technologies

The development of new products and services that are related to energy technologies is a further topic of our survey. The percentage of firms that developed new products and services in the field of energy-related technologies and introduced them to the market (innovations) in the reference period amounted to 9% in Switzerland, 11% in Germany and 13% in Austria (Figure 4.1). In Austria and particularly in Germany the share of innovating firms in manufacturing is higher than in the (reduced) service sector, which covers only "information technology services" and "technical services"; the shares in manufacturing and services are of the same magnitude in Switzerland. As for innovation in general, large firms show a higher innovation propensity than smaller firms.

A more detailed analysis by industry is found in Table A.3 in Appendix 1. Vehicles (CH: 14%; Germany: 49%; Austria: 35%), machinery and equipment (CH: 17%; Germany: 19%; Austria: 28%) and electrical machinery (CH: 14%; Germany: 30%; Austria: 20%) are the industries with the highest shares of innovating firms in all three countries. In addition, relatively high share of innovating firms show the industry "environment/water" (12%) in Switzerland and the industry "non-metallic minerals" (49%) in Austria.

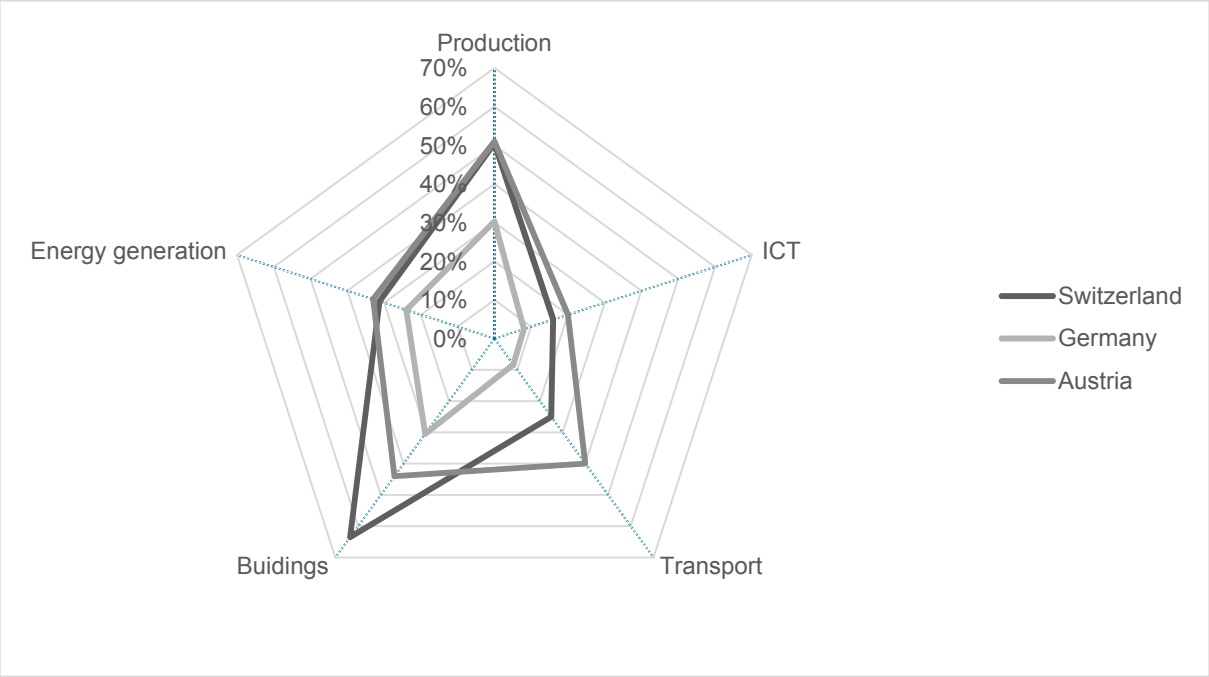
Figure 4.1: Share of innovating firms (in % of firms)



The questionnaire distinguished the same five categories of energy-related technologies for innovation activities as it did for technology adoption (see Figure 3.2). Figure 4.2 shows the shares of (innovating) firms that report innovations in the five fields that are considered in this study. On the average of all three countries building technologies is the most frequently named technology category, followed by production-related technologies and technologies for the generation of renewable energy sources. The specialization in production-related technologies and in building technologies is particularly strong in

Switzerland (51% and 64%, resp.) and Austria (51% and 44%, resp.). The activities of German firms are more evenly distributed. A more detailed analysis by industry is found in Table A.3 in the Appendix 1.

Figure 4.2: Share of innovating firms by field of technology (in % if innovating firms)



4.2 Innovation effort and innovation success

The innovation effort for new energy-related technologies is measured by R&D expenditures. Not all firms with energy-related innovations conduct R&D, many of them invest in other categories of innovation inputs. Figure 4.3 shows the percentage of manufacturing firms with innovations in the field of energy-related technology that conducted R&D in this technology field in the reference period.[5] This is the case for 42% of German innovating firms, 40% of Swiss innovating firms and 36% of Austrian innovating firms. The average share of energy-related R&D expenditures in the total R&D expenditures of these firms is given in Figure 4.4. In Switzerland, firms with innovations in the field of energy-related technology allocated 29% of their total R&D budget to energy-related technology. In Germany, this share is almost the same (28%), while firms from Austria that developed new energy-related technologies are stronger focused in their R&D efforts on this particular field of technology (42%). These figures show that firms innovating in the energy field invest a significant share of their total R&D budget in energy-related R&D.

[5] We focus here on manufacturing firms because for the service sectors, in which only two industries are taken into consideration in our survey, only few observations are available.

Figure 4.3: Share of firms with energy-related R&D activities – Manufacturing

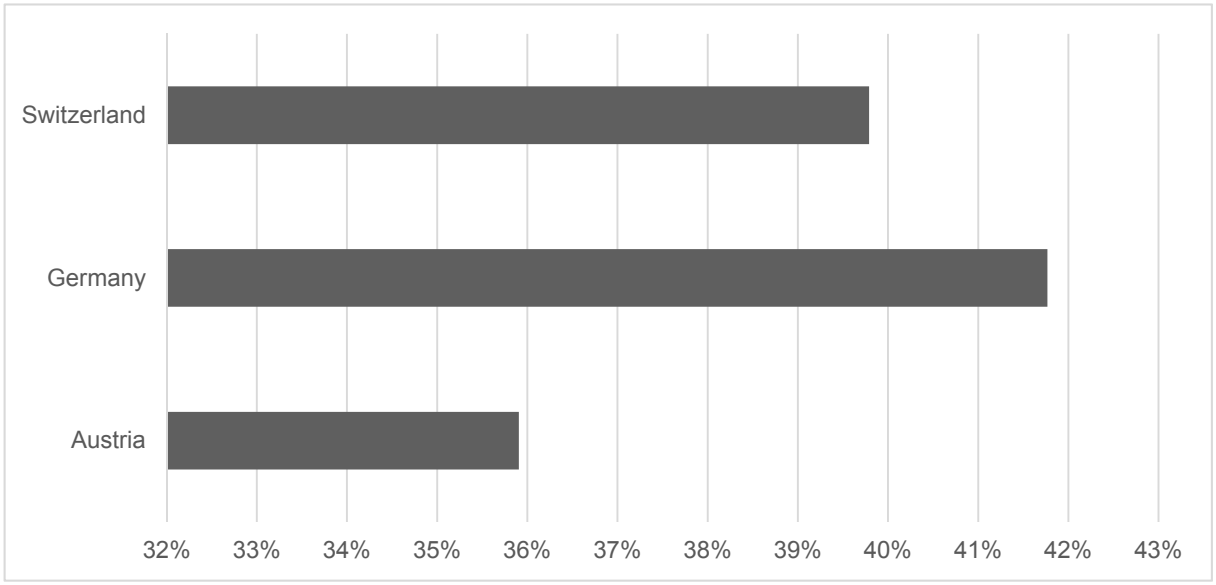
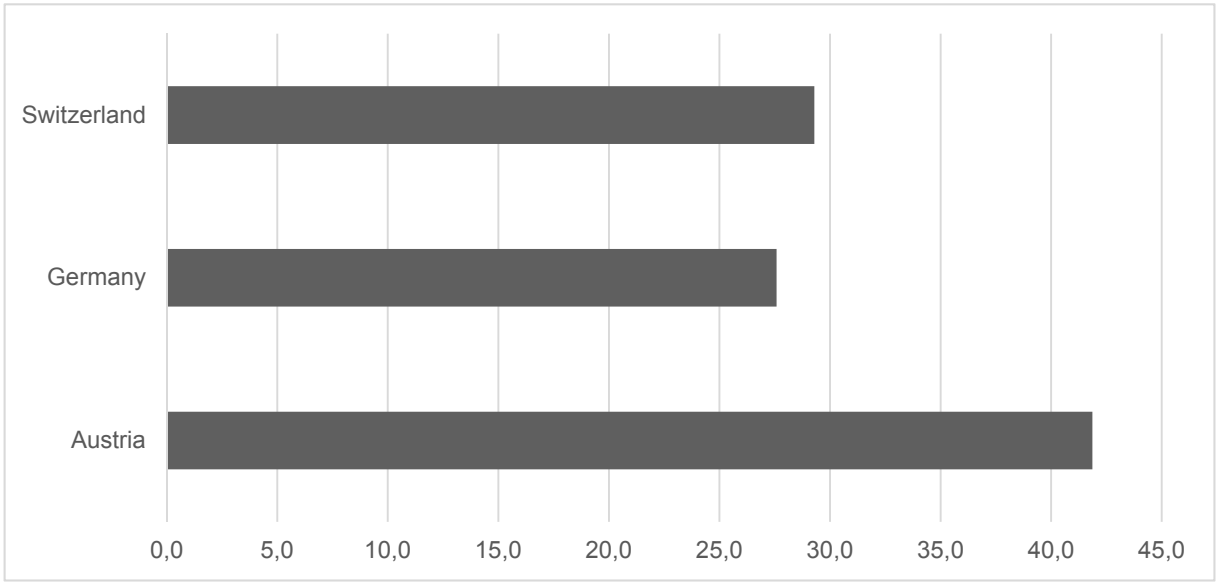
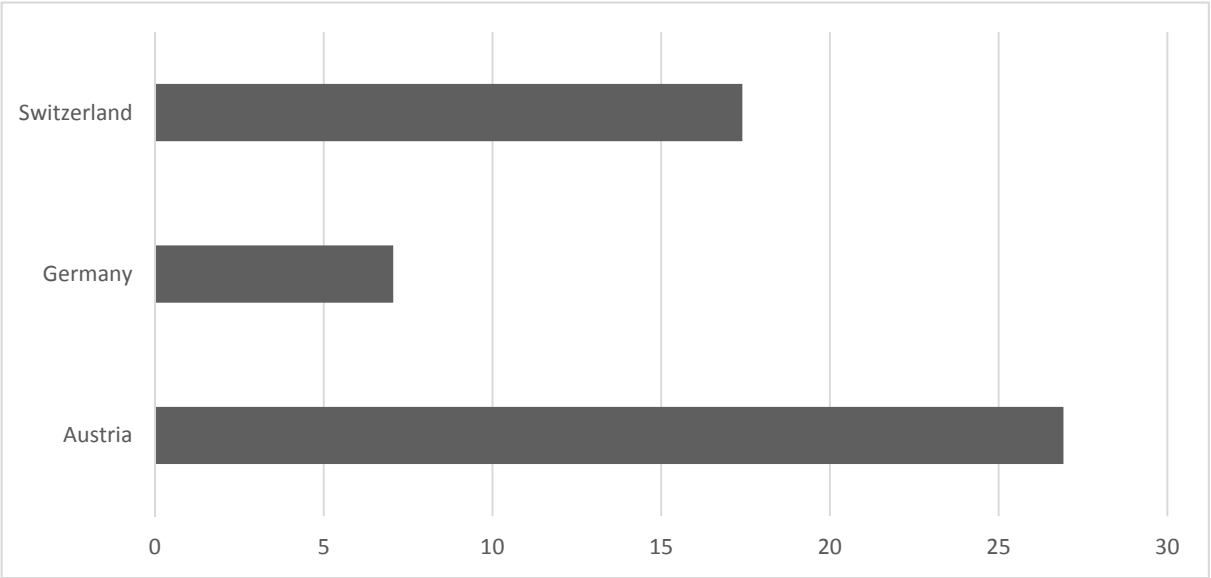


Figure 4.4: Share of energy-related R&D expenditures (in % of total R&D) - Manufacturing



The sales share of energy-related innovative products is an important indicator of innovation success. Figure 4.5 presents the average sales share of such innovative products in 2014 for manufacturing firms that reported the introduction of such innovations in the reference period for all three countries (see footnote 3). This share is at highest in Austria (about 27%), followed by Switzerland (about 17%) and, with some distance, Germany (7%). The ratio of the share of energy-related R&D to the sales share of innovative energy related-products/services might be interpreted as an indicator of the effectiveness of R&D effort. Austrian firms show the highest ratio, i.e. the highest effectiveness, followed by Swiss firms, and with some distance, German firms. An explanation for the small share of the German firms may be that in Germany more large firms with a wide technological portfolio get engaged in more explorative energy-related R&D with small short-term innovation impact, contrary to Switzerland and Austria, where more highly specialized small firms invest in the development of energy-related new products and services.

Figure 4.5: Sales share of innovative energy-related products/services (in %) - Manufacturing

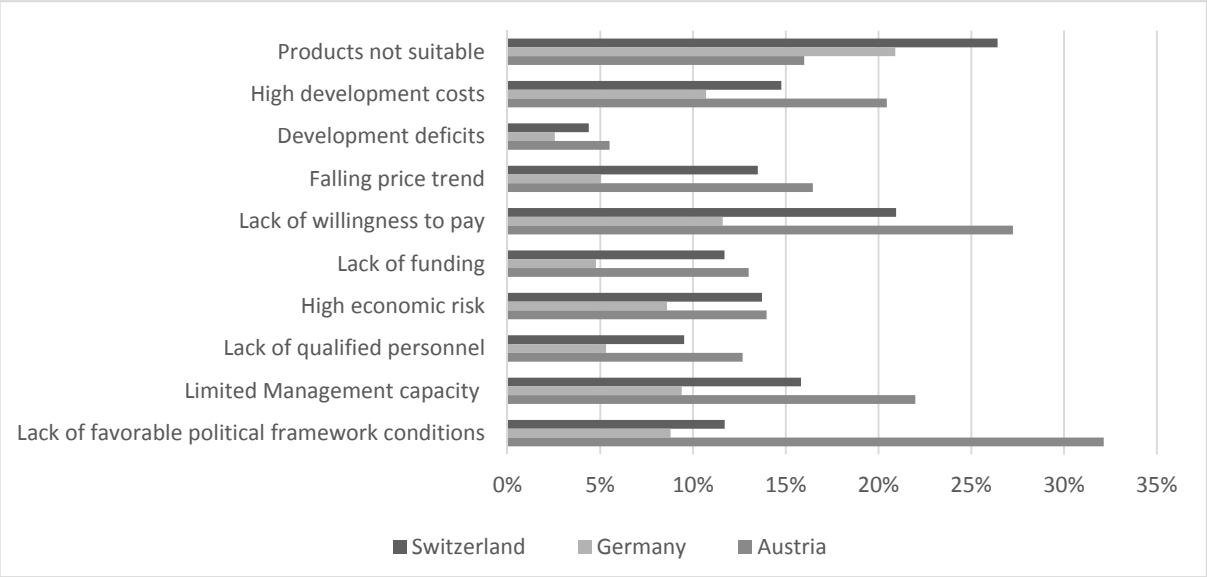


4.3 Obstacles of innovation in the energy field

Our questionnaire distinguishes 10 possible obstacles of innovation activities in the field of energy-related technologies covering all possible factors that could hamper the development and introduction of new products and service in the energy field. The obstacles are measured on a four-point Likert scale. Three of these obstacles are related to lack of resources (financial, personnel, managerial capacities). Further obstacles refer to unfavorable political conditions (e.g., lack of public support), lack of demand for such energy-related products, too high economic risks, falling prices, too high development cost, too large technological advance of competitors, and finally to the fact that a firm's product portfolio may not be suitable for this type of innovation.

In Figure 4.6 is presented the percentage of firms that report on the two upper levels "high relevance" or "very high relevance" of a certain obstacle. The most frequently reported obstacle on the average of all three countries is the obstacle "a firm's products are not suitable for this type of innovation", followed by "lack of demand for such products" and "lack of favorable political conditions (e.g., public subsides)". There are differences among the countries as to the frequency of responds for relevant obstacles, the German firms showing stronger reservation to report high or very high relevance of obstacles. The Swiss and Austrian responses rates are similar with two exceptions. First, 26% of Swiss firms report high or very high relevance of the obstacle "a firm's products are not suitable for this type of innovation" (Germany: 21%; Austria: 16%), thus showing much higher relevance of this obstacle than in the other two countries. Second, 32% of Austrian firms report high or very high relevance of the obstacle unfavorable political conditions (particularly, legal uncertainty) (Switzerland: 12%; Germany: 9%), thus showing much higher relevance of this obstacle than in the other two countries.

Figure 4.6: Obstacles of innovation (% of firms reporting at least "some relevance")



5 Energy-related factors and policy instruments influencing firms' behavior

The questionnaire used in this study distinguishes seven energy-related factors, four of them refer to different categories of energy policy that potentially influence firm operations. The policy-related factors are: (a) energy taxes/duties; (b) public financial support (subsides); (c) regulation by law; and (d) negotiated agreements (to reduce energy consumption) / industry-specific standards. The three other factors that could influence energy behavior are: (a) high or strongly fluctuating energy prices; (b) possible energy shortages; and (c) development of market demand in favor of energy-efficient and/or energy-efficiently produced goods and services as well as goods and services produced using renewable energy sources. Firms report the degree of relevance of these factors measured on a three-point Likert scale. In the econometric part of the project, we investigate the relationship between these factors and the willingness to adopt energy-related technologies.

Figure 5.1 shows the percentage of all firms in each country that report "high relevance" (level 3) for a certain factor in the period 2012-2014. The two most frequently named factors with high relevance were "high/strongly fluctuating energy prices" (9% to 22% depending on country) and "energy taxes/duties" (11% to 18% depending on country). German and Austrian enterprises report these two factors more frequently than Swiss firms. The relevance of all seven factors seem to be more equally distributed in Switzerland than in the other two countries, presumably reflecting, first, the fact that energy taxes are not so high in Switzerland and, second, that the most energy-intensive part of manufacturing (e.g., production of metals, basic chemicals) that would be stronger affected by energy prices is smaller than in the other two countries.

Table 5.1 presents the percentage of firms in every country that report “high relevance” (level 3) or “some relevance” (level 2) for a certain factor in the period 2012-2014. The picture is different than in Figure 5.1, much more firms reporting “some relevance” rather than “high relevance” of the factors/policy instruments in question. On average of all three countries the respective responses rate varies in Figure 5.2 between 18% (for energy shortages to 61% (for energy price fluctuations). The most frequently reported relevant factors/policy instruments are also for this indicator in all three countries energy prices (42% to 61% depending on country) and energy taxes/duties (43% to 53% depending on country). Also in this case, German and Austrian enterprises report these two factors more frequently than Swiss firms, and the relevance of all seven factors seem to be more equally distributed in Switzerland than in the other two countries. Thus, the informative value of Figure 5.1 and Figure 5.2 almost the same, only the magnitude of the percentage of answering firms differs. The least relevant factor in all three countries is energy shortages (18% to 20% depending on country).

A more detailed analysis by sector and sub-sector is found in Table A.4 in the Appendix. On average of all three countries firms belonging to the low-tech sub-sector reported more frequently relevance of any of the seven factors/policy instruments then high-tech firms, firms from “traditional” service industries (such as trade or transport) more frequently than firms from knowledge-intensive (“modern”) service industries (e.g., information technology services, telecommunication). Further, on the whole service firms seem to assess energy-related factors and policy instruments as less relevant for their activities than manufacturing firms. This is consistent with the fact that manufacturing firms are in general more energy-intensive than service firms.

Figure 5.1: Energy-related factors/policies (% of firms reporting "high relevance")

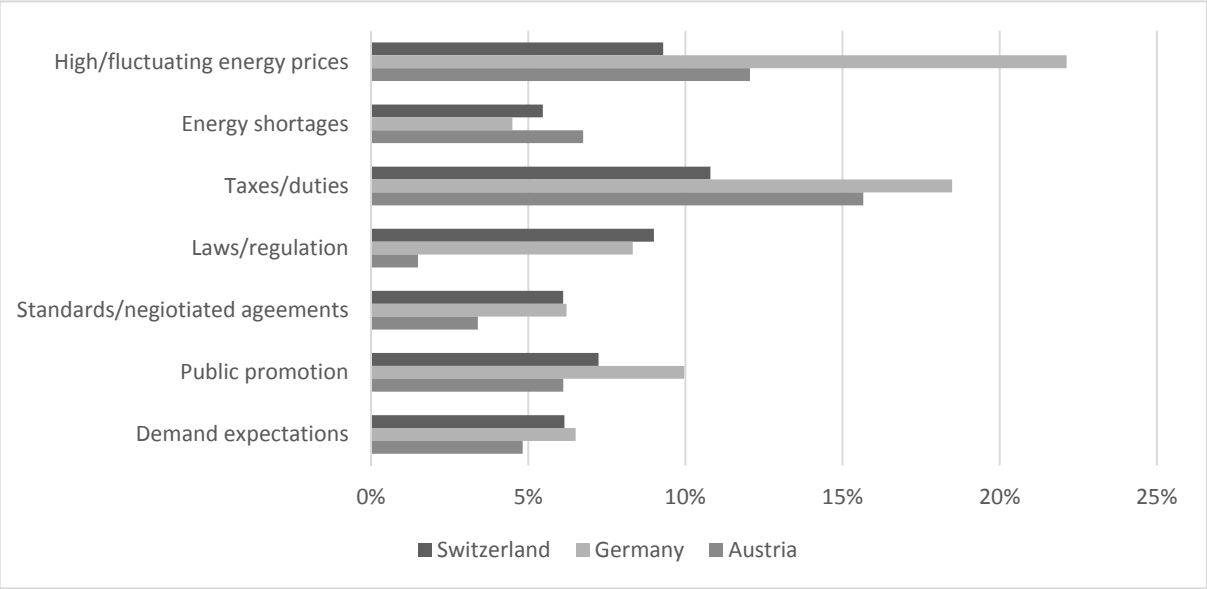
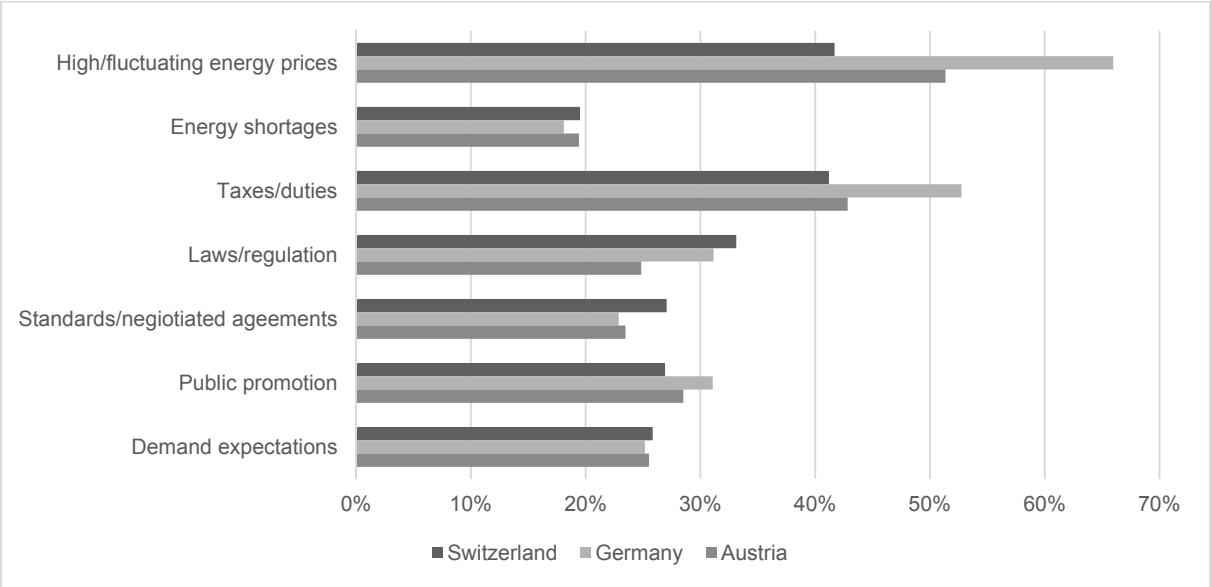


Figure 5.2: Energy-related factors/policies (% of firms reporting at least "some relevance")



6 Characteristics of firms and energy-related factors and policy instruments

The seven energy-related factors/policy instruments that are considered to be relevant drivers of the adoption of energy-saving technologies and/or the use of renewable energy sources are central for the present study. Therefore, it is important to investigate the characteristics in terms of *resource endowment, cost structure, performance*, and *competition conditions* of the firms reporting at least some relevance of these factors/policy instruments. To this end, we regressed binary variables for each factor/policy instrument on a series of variables including –besides measures of the above mentioned characteristics–also controls for firm size, firm age, foreign ownership, and industry affiliation. Table 6.1 to Table 6.4 show the results of these calculations in a compacted way showing only the signs (positive or negative) of the coefficients of the respective variables. These signs can be interpreted as hints for the direction of *(partial) correlations* between the seven energy-related factors/policy instruments and a series of firm characteristics.[6]

We comment here primarily on the findings based on the pooled data for all three countries (Table 6.1). The issue is: which firm type responds stronger than other firms to which factor or policy instrument.

[6] With the exception of the Austrian data we applied a multivariate probit estimator in order to take into account the possibility of interdependence of the answers due to the fact that multiple answers were asked for. For the Austrian data only separate probit models were technically feasible (with the exception of "public promotion"). Alternative estimates of separate probit models of the German and the Swiss data showed only small differences.

The following patterns are discernible:

- Energy costs as a percentage of sales generally correlate positively with the relevance assessment of all factors/policy instruments (one exception being demand expectations);
- Firms with relatively low labor costs and/or costs for intermediate inputs seem to assess energy price fluctuations, energy shortages and energy-related taxes as more relevant than other firms;
- Firms with high R&D expenditures per employee seem to evaluate laws and regulations as well as standards and voluntary energy-related agreements as more relevant than other firms;
- Firms with high shares of high-qualified employees, high R&D expenditures per employees and high gross investment expenditure per employee find the demand for energetically efficient products and services as more relevant than other firms (factor 7). It is noticeable that this firm category does not show above-average energy intensity. Presumably such firms are innovating in the energy field;
- No clear pattern is discernible for firms assessing public promotion in the energy field as more relevant than other firms;
- The firms' economic performance does not seem to influence their assessment of the seven factors/policy instruments;
- Competition conditions matter for all factors, but no clear pattern for different competition dimensions is discernible;
- Larger firms show a stronger tendency to assess any of the seven factors as more relevant than smaller firms.

The results at country level are quite heterogeneous.

Switzerland (Table 6.2):

- The findings on energy costs are the same as in the pooled data;
- Costs (labor costs and/or costs for intermediate inputs) do not correlate negatively with the factors energy prices and energy shortages as well as with the policy instrument energy taxes as in the pooled sample; costs for intermediate inputs correlate positively with public promotion and demand expectation for energy-related new products and services;
- Investment expenditure per employee correlates positively with factors prices and shortages as well with public promotion, R&D-intensity with laws/regulations and standards/negotiated agreements;
- Firms without exports seem to assess standards/negotiated agreements and public promotion as more relevant than other firms.

Germany (Table 6.3):

- The findings on energy costs are the same as in the pooled data (additional exception: energy shortages);
- Costs (labor costs and/or costs for intermediate inputs) matter in the same way as in the pooled sample, in this case not only for energy shortages and taxes but also for laws/regulations and public promotion;
- Investment expenditure per employee correlates positively with prices, taxes and public promotion, R&D intensity with regulations/standards;
- The share of high-qualified employees is negatively related with prices and taxes.

Austria (Table 6.4):

- The findings on energy costs are the same as in the pooled data;
- Positive correlation of labor costs and costs for intermediate inputs with shortages, standards/negotiated agreements, laws/regulations and demand expectations, respectively;
- Negative correlation of costs for intermediate inputs with shortages;
- Positive correlation of R&D intensity with laws/regulations and standards/negotiated agreements;
- Negative correlation of labor productivity with standards/negotiated agreements and demand expectations.

Table 6.1: Characteristics of firms and energy-relevant factors; pooled data of 3 countries

	Energy prices	Energy shortages	Energy taxes	Laws/ Regulation	Negotiated agreements/ standards	Public promotion	Demand expectations
Resources							
Investment expenditures p.c.	ns	ns	+	ns	ns	+	+
R&D expenditures p.c.	ns	ns	ns	+	+	ns	+
Tertiary-level education (employee share)	ns	ns	ns	ns	ns	ns	+
Costs							
Labor costs p.c.	-	-	-	ns	ns	-	ns
Intermediate input cost p.c.	-	-	-	ns	ns	ns	ns
Energy costs p.c.	+	+	+	+	+	+	ns
Performance							
Value added p.c.	-	ns	-	ns	ns	ns	ns
Exports	ns	ns	ns	-	ns	ns	-
Competition conditions							
Products become quickly outdated	+	ns	ns	ns	ns	ns	+
Technological change is difficult to predict	ns	+	ns	ns	+	+	ns
Market entry is a serious threat of own position	ns	ns	ns	+	ns	ns	ns
Demand development is difficult to predict	ns	ns	+	ns	ns	ns	ns
Other firm characteristics							
Firm age	ns	ns	ns	+	ns	+	+
Foreign-owned firm	ns	-	ns	ns	ns	-	ns
Medium-sized firm (50-249 empl.)	+	ns	+	+	+	+	+
Large (>=250 empl.)	+	+	+	+	+	+	+

Note: Characteristics of firms reporting “somewhat relevant” or “very relevant” for a series of energy-relevant factors as compared with firms reporting “no relevance” of these factors; pooled data of 3 countries. +/-: positive/negative and statistically significant (at the 10% test-level) coefficient (partial correlation) of the respective variable resulting from a multivariate probit regression of 7 factors/policy instruments on a series of firm characteristics; ns: statistically insignificant. The quantitative variables refer to the year 2014 and they are inserted in the regression as natural logarithms. Reference group for firm size is the group of small firms (5-49 employees).

Table 6.2: Characteristics of firms and energy relevant factors; Swiss data

	Energy prices	Energy shortages	Energy taxes	Laws/ Regulation	Negotiated agreements/ standards	Public promotion	Demand expectations
Resources							
Investment expenditures p.c.	+	+	ns	ns	ns	+	ns
R&D expenditures p.c.	ns	ns	ns	+	+	ns	ns
Tertiary-level education (employee share)	ns	ns	ns	ns	ns	ns	+
Costs							
Labor costs p.c.	ns	ns	ns	ns	ns	-	ns
Intermediate input cost p.c.	ns	ns	ns	ns	ns	+	+
Energy costs p.c.	+	+	+	+	+	+	ns
Performance							
Value added p.c.	ns	ns	ns	ns	ns	ns	ns
Exports	ns	ns	+	ns	-	-	-
Competition conditions							
Products become quickly outdated	ns	ns	ns	ns	ns	ns	+
Technological change is difficult to predict	ns	+	ns	ns	+	+	ns
Market entry is a serious threat of own position	ns	ns	ns	+	ns	ns	ns
Demand development is difficult to predict	ns	ns	+	ns	ns	ns	ns
Other firm characteristics							
Firm age	ns	ns	ns	ns	ns	+	+
Foreign-owned firm	ns	ns	ns	ns	ns	-	ns
Medium-sized firm (50-249 empl.)	+	ns	+	+	ns	+	ns
Large (>=250 empl.)	+	+	+	+	+	+	+

Note: Characteristics of firms reporting "somewhat relevant" or "very relevant" for a series of energy-relevant factors as compared with firms reporting "no relevance" of these factors; Swiss data. +/-: positive/negative and statistically significant (at the 10% test-level) coefficient (partial correlation) of the respective variable resulting from a multivariate probit regression of 7 factors/policy instruments on a series of firm characteristics; ns: statistically insignificant. The quantitative variables refer to the year 2014 and they are inserted in the regression as natural logarithms. Reference group for firm size is the group of small firms (5-49 employees). The competition variables are ordinal variables measured on a four-point Likert scale.

Table 6.3: Characteristics of firms and energy-relevant factors; German data

	Energy prices	Energy shortages	Energy taxes	Laws/ Regulation	Negotiated agreements/ Standards	Public promotion	Demand expectations
Resources							
Investment expenditures p.c.	+	ns	+	ns	ns	+	ns
R&D expenditures p.c.	ns	ns	ns	ns	+	ns	ns
Tertiary-level education (employee share)	-	ns	-	ns	ns	ns	+
Costs							
Labor costs p.c.	ns	+	ns	-	ns	-	ns
Intermediate input cost p.c.	-	-	-	-	ns	-	ns
Energy costs p.c.	+	ns	+	+	+	+	ns
Performance							
Value added p.c.	ns	ns	-	ns	ns	ns	ns
Exports	ns	ns	ns	ns	ns	ns	ns
Competition conditions							
Products become quickly outdated	+	ns	ns	ns	+	ns	+
Technological change is difficult to predict	ns	ns	ns	+	ns	+	ns
Products/services are easily copied	+	ns	ns	ns	ns	ns	-
Market entry is a serious threat of own position	ns	ns	ns	+	ns	ns	ns
Demand development is difficult to predict	ns	ns	ns	ns	ns	ns	ns
Other firm characteristics							
Firm age	+	ns	+	ns	ns	ns	ns
Foreign-owned firm	ns	ns	ns	ns	ns	-	ns
Medium-sized firm (50-249 empl.)	+	+	+	+	+	+	+
Large (>=250 empl.)	+	+	+	+	+	+	+

Note: Characteristics of firms reporting "somewhat relevant" or "very relevant" for a series of energy-relevant factors as compared with firms reporting "no relevance" of these factors; German data. +/-: positive/negative and statistically significant (at the 10% test-level) coefficient (partial correlation) of the respective variable resulting from a multivariate probit regression of 7 factors/policy instruments on a series of firm characteristics; ns: statistically insignificant. The quantitative variables refer to the year 2014 and they are inserted in the regression as natural logarithms. Reference group for firm size is the group of small firms (5-49 employees). The competition variables are ordinal variables measured on a four-point Likert scale.

Table 6.4: Characteristics of firms and energy-relevant factors; Austrian data

	Energy prices	Energy shortages	Energy taxes	Laws/ Regulation	Negotiated agreements/ Standards	Demand expectation
Resources						
Investment expenditures p.c.	ns	ns	ns	ns	ns	ns
R&D expenditures p.c.	ns	ns	ns	+	+	ns
Tertiary-level education (employee share)	ns	ns	ns	ns	ns	ns
Costs						
Labor costs p.c.	ns	+	ns	ns	+	ns
Intermediate input cost p.c.	ns	-	ns	+	ns	+
Energy costs p.c.	+	+	+	+	+	ns
Performance						
Value added p.c.	ns	ns	ns	ns	-	-
Exports	ns	ns	ns	ns	ns	ns
Competition conditions						
Products become quickly outdated	ns	ns	ns	-	ns	-
Technological change is difficult to predict	ns	ns	+	ns	ns	ns
Market entry is a serious threat of own position	ns	-	ns	ns	ns	ns
Demand development is difficult to predict	-	ns	-	ns	ns	ns
Other firm characteristics						
Firm age	+	ns	+	ns	ns	+
Foreign-owned firm	ns	ns	ns	ns	ns	ns
Medium-sized firm (50-249 empl.)	ns	ns	+	ns	ns	ns
Large (>=250 empl.)	ns	+	ns	+	+	ns

Note: Characteristics of firms reporting "somewhat relevant" or "very relevant" for a series of energy-relevant factors as compared with firms reporting "no relevance" of these factors; Austrian data. +/-: positive/negative and statistically significant (at the 10% test-level) coefficient (partial correlation) of the respective variable resulting from separate probit regressions of 6 factors/policy instruments on a series of firm characteristics; ns: statistically insignificant. Due to technical reasons estimates for factor 6 (public promotion) are not feasible. The quantitative variables refer to the year 2014 and they are inserted in the regression as natural logarithms. Reference group for firm size is the group of small firms (5-49 employees). The competition variables are ordinal variables measured on a four-point Likert scale.

A.1 Appendix 1

Table A.1: Percentage of firms adopting energy-related technologies by industry

	Switzerland	Germany	Austria	Total
Manufacturing				
Food/Beverages/Tobacco	41%	58%	73%	58%
Textiles/Clothing	26%	62%	60%	58%
Wood	32%	16%	63%	26%
Paper	37%	65%	43%	61%
Printing	42%	30%	53%	33%
Chemicals	31%	67%	37%	55%
Pharmaceuticals	33%	84%	51%	55%
Rubber/Plastics	44%	64%	51%	61%
Non-metallic Minerals	35%	57%	26%	53%
Basic Metals	54%	56%	89%	58%
Fabricated Metal Products	28%	51%	54%	49%
Machinery & Equipment	31%	49%	35%	47%
Electrical Equipment	35%	42%	57%	42%
Electronic & Optical Products	25%	41%	97%	44%
Repair/Installation	32%	54%	27%	49%
Vehicles	28%	79%	8%	69%
Other Manufacturing	25%	62%	80%	61%
Water/Environment	51%	62%	8%	39%
Construction	21%	33%	15%	29%
Services				
Wholesale Trade	29%	50%	86%	49%
Retail Trade	24%	n/a	2%	10%
Accommodation/Restaurants	24%	n/a	96%	48%
Transportation	37%	33%	24%	32%
Telecommunications	12%	44%	37%	39%
Publishing/Media	53%	35%	32%	34%
Information Technology/Services	29%	42%	10%	37%
Banks/Insurance	22%	39%	72%	46%
Real Estate/Rental&Leasing	26%	21%	14%	21%
Technical Commercial Services	17%	31%	17%	26%
Other Commercial Services	8%	31%	28%	29%
Personal Services	40%	n/a	55%	52%
Total	25%	40%	32%	37%

Table A.2: Percentage of firms adopting energy-related management systems by industry

	Switzerland	Germany	Austria	Total
Manufacturing				
Food/Beverages/Tobacco	34%	21%	26%	22%
Textiles/Clothing	24%	29%	16%	25%
Wood	10%	13%	5%	11%
Paper	44%	45%	52%	46%
Printing	23%	16%	5%	16%
Chemicals	28%	39%	36%	37%
Pharmaceuticals	24%	32%	2%	11%
Rubber/Plastics	40%	31%	26%	31%
Non-metallic Minerals	27%	23%	24%	24%
Basic Metals	70%	57%	51%	57%
Fabricated Metal Products	33%	17%	47%	19%
Machinery & Equipment	26%	11%	35%	14%
Electrical Equipment	26%	31%	25%	30%
Electronic & Optical Products	23%	12%	50%	18%
Repair/Installation	2%	13%	0%	11%
Vehicles	7%	22%	23%	21%
Other Manufacturing	11%	28%	26%	26%
Water/Environment	65%	23%	7%	18%
Construction	7%	8%	2%	7%
Services				
Wholesale Trade	29%	11%	8%	13%
Retail Trade	7%	n/a	75%	43%
Accommodation/Restaurants	23%	n/a	11%	19%
Transportation	23%	7%	1%	7%
Telecommunications	12%	3%	0%	1%
Publishing/Media	29%	7%	0%	4%
Information Technology/Services	8%	14%	1%	13%
Banks/Insurance	5%	10%	5%	8%
Real Estate/Rental&Leasing	13%	4%	14%	7%
Technical Commercial Services	22%	3%	17%	8%
Other Commercial Services	4%	3%	2%	3%
Personal Services	27%	n/a	11%	14%
Total	17%	11%	13%	12%

Table A.3: Percentage of firms developing new energy-related products and services by industry

	Switzerland	Germany	Austria	Total
Manufacturing				
Wood	9%	5%	0%	5%
Paper	0%	9%	0%	7%
Chemicals	2%	10%	0%	6%
Rubber/Plastics	3%	22%	14%	20%
Non-metallic Minerals	7%	3%	49%	7%
Basic Metals	2%	14%	21%	13%
Fabricated Metal Products	6%	4%	9%	5%
Machinery & Equipment	17%	19%	28%	19%
Electrical Equipment	14%	30%	20%	28%
Electronic & Optical Products	7%	18%	2%	14%
Repair/Installation	11%	8%	23%	11%
Vehicles	14%	49%	35%	46%
Water/Environment	12%	n/a	n/a	12%
Services				
Information Technology	8%	5%	1%	5%
Technical Commercial Services	9%	10%	16%	11%
Total	7%	11%	13%	10%

A.2 Appendix 2

Table A.4: Importance of energy-related factors and policies

	HIGH-TECH	LOW-TECH	CON-STRUCTION	MODERN SERVICES	TRADI-TIONAL SERVICES	TOTAL
All countries						
Energy prices	66%	79%	72%	39%	61%	61%
Energy shortages	13%	24%	22%	10%	21%	18%
Taxes	53%	73%	57%	29%	48%	50%
Laws/regulations	32%	36%	36%	15%	38%	30%
Stand-ards/agreements	29%	31%	28%	10%	28%	23%
Public promotion	35%	41%	36%	18%	30%	30%
Demand	23%	25%	40%	16%	25%	25%
Switzerland						
Energy prices	43%	57%	37%	17%	53%	42%
Energy shortages	24%	24%	25%	13%	19%	20%
Taxes	47%	54%	39%	19%	50%	41%
Laws/regulations	35%	45%	33%	16%	39%	33%
Stand-ards/agreements	28%	36%	30%	12%	32%	27%
Public promotion	24%	34%	38%	20%	25%	27%
Demand	21%	28%	44%	22%	22%	26%
Germany						
Energy prices	69%	81%	73%	46%	67%	66%
Energy shortages	11%	23%	22%	10%	22%	18%
Taxes	54%	74%	59%	33%	48%	53%
Laws/regulations	32%	36%	35%	18%	37%	31%
Stand-ards/agreements	29%	30%	24%	10%	27%	23%
Public promotion	35%	44%	35%	16%	31%	31%
Demand	22%	25%	38%	15%	25%	25%
Austria						
Energy prices	63%	84%	93%	29%	45%	51%
Energy shortages	23%	34%	27%	11%	19%	19%
Taxes	49%	78%	56%	22%	46%	43%
Laws/regulations	27%	30%	42%	4%	40%	25%
Stand-ards/agreements	31%	30%	55%	6%	28%	23%
Public promotion	41%	24%	40%	22%	32%	29%
Demand	33%	23%	57%	13%	27%	26%

Note: Table shows percentage of firms reporting “some importance” or “high importance” of a certain factor / policy instrument by sector and sub-sector. High-tech industries comprises: chemicals, pharmaceuticals, rubber/plastics, machinery & equipment, electrical equipment, electronic and optical products, repair and installation, medical instruments, vehicles; low-tech comprises the rest of the manufacturing industries (see Table A.5). Modern services comprises: telecommunication, publishing/media, information technology/services, bank/insurances, technical commercial services, other commercial services; traditional services refers to the rest of the service industries (see Table A.5).

A.3 Appendix 3

Data Collection

Questionnaire

The data were collected by means of an identical survey carried out in all three countries in the period between spring and autumn 2015. Besides questions on various firm-level economic variables such as employment, share of high-qualified employees, sales, labor costs, costs for intermediate inputs, exports, R&D expenditure, sale share of innovative products, and other more, the questionnaire contained four sections referring to energy-related issues: (a) information on energy costs, used energy sources; (b) information on the relevance of a series of energy-related factors (e.g., energy prices) and policy instruments (e.g., taxes, subsides); on the use of energy-related management systems; (c) information on the willingness to adopt energy-saving technologies and/or use of renewable energy sources; on the environmental impact the adoption of such technologies on energy consumption and CO2 emissions; on possible obstacles of technology adoption; (d) information on the propensity to innovate in various energy-related fields (product innovation); on the R&D effort as well as the innovation success related with such new products and services; on possible innovation obstacles.

Sample construction

Switzerland

The firm survey was based on the KOF firm-panel. It is a (with respect to firm size) disproportional stratified sample, drawn from the national census of enterprises (2008) and containing firms with more than five employees. The sample covers 34 2-digit industries (NOGA classification) form all sectors of the economy and – within each of industry – three different size classes with a complete coverage of large firms. The limits for the three size classes (criterion: employment in full-time equivalents) are determined by “optimal stratification” that takes into account the different size distributions of firms within industries.

Germany

The firm survey was based on the Mannheim Innovation Panel (MIP). The MIP is run by ZEW and is a stratified random sample of firms with 5 or more employees. The MIP sample includes 896 strata (56 2-digit sectors, 8 size classes, 2 regions) and is disproportionally stratified, with the variance of innovation intensity and the total population per stratum determining the drawing probability. The MIP is a panel sample. The original sample was drawn in 1993 and has been refreshed since every second year. The original sample as well as refreshments were drawn from the Mannheim Enterprise Panel (MUP) which is a kind of business register maintained by ZEW in close cooperation with Creditreform, Germany's largest credit rating agency. For the survey on energy technologies, all firms responding in the 2015 wave of the MIP and providing data on their innovation activities and other key variables (energy costs, market environment) constitute the gross sample. All firms in the gross sample were contacted via phone and asked to participate in the survey on energy technologies. In case of a positive response, firms received an E-mail with the link to the online survey on energy technologies.

Austria

In Austria the survey was based on a framelist drawn from the Herold MDonline, a commercially available marketing database, and consisted of data on 49370 companies with 5 or more employees from

34 industrial groupings (covering 64 NACE-2-digit-codes). Out of this framelist a gross sample of 7091 (adjusted, 7169 unadjusted) companies was drawn. All companies in the framelist with 100 or more employees were selected for the gross sample (2690 adjusted, 2725 unadjusted). Furthermore, all companies with less than 100 employees and being attributed to a NACE-2-digit-code showing no more than 83 companies in the framelist were assigned to the gross sample. Among the remaining companies, i.e. having less than 100 employees and being attributed to a NACE-2-digit-code showing more than 83 companies in the framelist, a random sample of 83 (unadjusted) companies was selected for each NACE-2-digit-code.

Composition of original sample and sample of received valid questionnaires

Switzerland

Table A.5: Response rates

Sector/Branch	NACE R2	Small	Medium	Large	Total
		Percentage Responses			
Industry		*31.0*	*37.3*	*39.5*	*34.4*
Food/Beverages/Tobacco	10,11,12	41.0	41.1	46.7	41.4
Textiles/Clothing	13,14,15	33.3	35.0	50.0	35.6
Wood	16	33.3	39.5	46.2	37.9
Paper	17	38.9	47.4	20.0	38.3
Printing	18	33.3	50.0	53.8	44.2
Chemicals	19,2	37.3	44.7	12.5	38.5
Pharmaceuticals	21	34.4	22.7	50.0	31.8
Rubber/Plastics	22	31.1	54.3	35.3	41.7
Non-metallic Minerals	23	27.9	34.2	25.0	30.3
Basic Metals	24	25.9	45.8	44.4	36.7
Fabricated Metal Products	25	26.6	30.7	38.9	29.6
Machinery & Equipment	28	26.1	40.2	46.3	35.0
Electrical Equipment	27	34.0	47.5	50.0	38.6
Electronic & Optical Products	26	26.0	30.8	20.0	27.9
Repair/Installation	33	37.5	37.5	66.7	39.5
Medical Technology	325	25.9	33.3	0.0	26.9
Vehicles	29,30	30.0	20.0	66.7	29.2
Other Manufacturing	31,321,322,323,324,329	43.8	25.0	36.4	36.5
Water/Environment	36,37,38,39	26.3	45.5	40.0	37.0
Construction	41,42,43	*22.2*	*31.2*	*30.2*	*26.9*
Services		*27.1*	*32.4*	*30.1*	*29.3*
Wholesale Trade	45,46	30.8	39.0	32.7	34.6
Retail Trade	47,95	24.2	31.6	66.7	25.9
Accommodation/Restaurants	55,56	19.2	25.0	23.1	22.2
Transportation	49,50,51,52,79	25.6	32.0	28.6	28.1
Telecommunications	53,61	14.7	27.3	100.0	21.3
Publishing/Media	58,59,60	19.0	33.3	0.0	25.0
Information Technology/Services	62,63	43.8	22.9	17.1	27.5
Banks/Insurance	64,65,66	28.7	33.3	0.0	29.8
Real Estate/Rental&Leasing	68,77,81	32.7	26.7	45.5	31.0
Technical Commercial Services	71,72	41.3	48.1	33.3	42.4
Other Commercial Services	69,70,73,74,78,80,82	32.8	25.0	50.0	30.4
Personal Services	96	5.0	66.7	25.0	21.4
Total		*28.4*	*34.6*	*34.6*	*31.4*

Table A.6: Composition of the received responses (valid questionnaires)

Sector/Branch	Small	Medium	Large	Total	Small	Medium	Large
	Number of Firms				Percentage (in Sector/Branch)		
Industry	*402*	*408*	*92*	*902*	*44.6*	*45.2*	*10.2*
Food/Beverages/Tobacco	55	39	7	101	54.5	38.6	6.9
Textiles/Clothing	9	14	3	26	34.6	53.8	11.5
Wood	12	15	6	33	36.4	45.5	18.2
Paper	7	9	2	18	38.9	50.0	11.1
Printing	10	17	7	34	29.4	50.0	20.6
Chemicals	28	21	1	50	56.0	42.0	2.0
Pharmaceuticals	21	5	1	27	77.8	18.5	3.7
Rubber/Plastics	14	25	6	45	31.1	55.6	13.3
Non-metallic Minerals	12	13	2	27	44.4	48.1	7.4
Basic Metals	7	11	4	22	31.8	50.0	18.2
Fabricated Metal Products	50	61	14	125	40.0	48.8	11.2
Machinery & Equipment	42	74	19	135	31.1	54.8	14.1
Electrical Equipment	33	19	4	56	58.9	33.9	7.1
Electronic & Optical Products	58	54	2	114	50.8	47.3	1.8
Repair/Installation	9	6	2	17	52.9	35.3	11.8
Medical Technology	7	7	0	14	50.0	50.0	0.0
Vehicles	9	3	2	14	64.3	21.4	14.3
Other Manufacturing	14	5	8	27	51.9	18.5	29.6
Water/Environment	5	10	2	17	29.4	58.8	11.8
Construction	*57*	*77*	*16*	*150*	*38.0*	*51.3*	*10.7*
Services	*398*	*306*	*59*	*763*	*52.2*	*40.1*	*7.7*
Wholesale Trade	69	85	16	170	40.6	50.0	9.4
Retail Trade	97	31	2	130	74.6	23.8	1.5
Accommodation/Restaurants	25	32	6	63	39.7	50.8	9.5
Transportation	50	40	2	92	54.3	43.5	2.2
Telecommunications	5	3	2	10	50.0	30.0	20.0
Publishing/Media	4	7	0	11	36.4	63.6	0.0
Information Technology/Services	14	8	6	28	50.0	28.6	21.4
Banks/Insurance	48	27	0	75	64.0	36.0	0.0
Real Estate/Rental&Leasing	18	16	5	39	46.2	41.0	12.8
Technical Commercial Services	26	26	9	61	42.6	42.6	14.8
Other Commercial Services	41	27	7	75	54.7	36.0	9.3
Personal Services	1	4	4	9	11.1	44.4	44.4
Total	*857*	*791*	*167*	*1815*	*47.2*	*43.6*	*9.2*

Table A.7: Composition of the original sample

Sector/Branch	Small	Medium	Large	Total	Small	Medium	Large
	Number of Firms				Percentage (in Sector/Branch)		
Industry	*1297*	*1095*	*233*	*2625*	*49.4*	*41.7*	*8.9*
Food/Beverages/Tobacco	134	95	15	244	54.9	38.9	6.1
Textiles/Clothing	27	40	6	73	37.0	54.8	8.2
Wood	36	38	13	87	41.4	43.7	14.9
Paper	18	19	10	47	38.3	40.4	21.3
Printing	30	34	13	77	39.0	44.2	16.9
Chemicals	75	47	8	130	57.7	36.2	6.2
Pharmaceuticals	61	22	2	85	71.8	25.9	2.4
Rubber/Plastics	45	46	17	108	41.7	42.6	15.7
Non-metallic Minerals	43	38	8	89	48.3	42.7	9.0
Basic Metals	27	24	9	60	45.0	40.0	15.0
Fabricated Metal Products	188	199	36	423	44.4	47.0	8.5
Machinery & Equipment	161	184	41	386	41.7	47.7	10.6
Electrical Equipment	97	40	8	145	66.9	27.6	5.5
Electronic & Optical Products	223	175	10	408	54.7	42.9	2.1
Repair/Installation	24	16	3	43	55.8	37.2	7.0
Medical Technology	27	21	4	52	51.9	40.4	7.7
Vehicles	30	15	3	48	62.5	31.2	6.2
Other Manufacturing	32	20	22	74	43.2	27.0	29.7
Water/Environment	19	22	5	46	41.3	47.8	10.9
Construction	*257*	*247*	*53*	*557*	*46.1*	*44.3*	*9.5*
Services	*1466*	*945*	*196*	*2607*	*56.2*	*36.2*	*7.5*
Wholesale Trade	224	218	49	491	45.6	44.4	10.0
Retail Trade	400	98	3	501	79.8	19.6	0.6
Accommodation/Restaurants	130	128	26	284	45.8	45.1	9.2
Transportation	195	125	7	327	59.6	38.2	2.1
Telecommunications	34	11	2	47	72.3	23.4	4.3
Publishing/Media	21	21	2	44	47.7	47.7	4.5
Information Technology/Services	32	35	35	102	31.4	34.3	34.3
Banks/Insurance	167	81	4	252	66.3	32.1	1.6
Real Estate/Rental&Leasing	55	60	11	126	43.7	47.6	8.7
Technical Commercial Services	63	54	27	144	43.8	37.5	18.8
Other Commercial Services	125	108	14	247	50.6	43.7	5.7
Personal Services	20	6	16	42	47.6	14.3	38.1
Total	*3020*	*2287*	*482*	*5789*	*52.2*	*39.5*	*8.3*

Germany

Table A.8: Response rates

Sector/Branch	NACE R2	Small	Medium	Large	Total
		Percentage Responses			
Industry		*34.6*	*41.6*	*41.7*	*37.5*
1 Food/Beverages/Tobacco	10,11,12	*20.9*	*32.8*	*37.9*	*25.5*
2 Textiles/Clothing	13,14,15	*32.6*	*49.2*	*50.0*	*38.7*
3 Wood	16	*19.4*	*46.2*	*50.0*	*28.3*
4 Paper	17	*42.1*	*46.2*	*40.0*	*43.2*
5 Printing	18	*37.7*	*54.5*	*62.5*	*43.0*
6 Chemicals	19,2	*51.4*	*44.7*	*34.5*	*46.0*
7 Pharmaceuticals	21	*22.7*	*42.9*	*25.0*	*29.2*
8 Rubber/Plastics	22	*45.8*	*38.0*	*51.9*	*44.3*
9 Non-metallic Minerals	23	*33.8*	*23.1*	*18.8*	*28.9*
10 Basic Metals	24	*39.4*	*50.0*	*38.9*	*43.5*
11 Fabricated Metal Products	25	*28.7*	*42.0*	*50.0*	*33.7*
12 Machinery & Equipment	28	*34.2*	*33.0*	*40.0*	*35.3*
13 Electrical Equipment	27	*41.4*	*34.1*	*63.6*	*42.7*
14 Electronic & Optical Products	26	*43.8*	*43.7*	*30.4*	*42.6*
15 Repair/Installation	33	*29.1*	*60.0*	*43.8*	*34.6*
16 Medical Technology	325	*27.9*	*33.3*	*0.0*	*27.7*
17 Vehicles	29,30	*34.1*	*35.9*	*40.9*	*37.1*
18 Other Manufacturing	31,32ex325	*31.9*	*45.2*	*60.0*	*37.9*
19 Water/Environment	36,37,38,39	*44.0*	*50.0*	*48.3*	*46.1*
Construction	*41,42,43*	*28.0*	*50.0*	*71.4*	*32.3*
Services		*35.6*	*32.7*	*38.1*	*35.4*
Wholesale Trade	45,46	*31.1*	*27.5*	*36.4*	*30.9*
Retail Trade	47,95	*39.5*	*37.5*	*0.0*	*36.7*
Accommodation/Restaurants	55,56	*40.0*	*28.6*	*100.0*	*38.5*
Transportation	49,50,51,52,79	*30.7*	*34.0*	*40.4*	*32.6*
Telecommunications	53,61	*27.3*	*40.0*	*28.6*	*29.5*
Publishing/Media	58,59,60	*37.1*	*40.0*	*30.0*	*37.3*
Information Technology/Services	62,63	*43.8*	*31.8*	*36.8*	*41.5*
Banks/Insurance	64,65,66	*38.6*	*43.6*	*50.9*	*42.4*
Real Estate/Rental&Leasing	68,77,81	*30.7*	*37.8*	*18.4*	*29.9*
Technical Commercial Services	71,72	*38.6*	*31.0*	*44.4*	*37.9*
Other Commercial Services	69,70,73,74,78,80,82	*35.0*	*25.5*	*37.5*	*33.9*
Other Services	84-93,96	*9.1*	*33.3*	*100.0*	*26.3*
Mining, Agriculture	*1-9*	*36.9*	*47.6*	*66.7*	*40.4*
Total		*35.0*	*38.7*	*40.7*	*36.4*

Table A.9: Composition of the received responses (valid questionnaires)

Sector/Branch	Small	Medium	Large	Total	Small	Medium	Large
	Number of Firms				Percentage (in Sector/Branch)		
Industry	*646*	*374*	*166*	*1186*	*54.5*	*31.5*	*14.0*
Food/Beverages/Tobacco	38	21	11	*70*	*54.3*	*30.0*	*15.7*
Textiles/Clothing	42	32	5	*79*	*53.2*	*40.5*	*6.3*
Wood	13	12	3	*28*	*46.4*	*42.9*	*10.7*
Paper	16	12	4	*32*	*50.0*	*37.5*	*12.5*
Printing	29	12	5	*46*	*63.0*	*26.1*	*10.9*
Chemicals	37	17	10	*64*	*57.8*	*26.6*	*15.6*
Pharmaceuticals	5	6	3	*14*	*35.7*	*42.9*	*21.4*
Rubber/Plastics	33	19	14	*66*	*50.0*	*28.8*	*21.2*
Non-metallic Minerals	27	9	3	*39*	*69.2*	*23.1*	*7.7*
Basic Metals	13	17	7	*37*	*35.1*	*45.9*	*18.9*
Fabricated Metal Products	66	42	10	*118*	*55.9*	*35.6*	*8.5*
Machinery & Equipment	38	32	28	*98*	*38.8*	*32.7*	*28.6*
Electrical Equipment	36	14	14	*64*	*56.3*	*21.9*	*21.9*
Electronic & Optical Products	78	31	7	*116*	*67.2*	*26.7*	*6.0*
Repair/Installation	34	12	7	*53*	*64.2*	*22.6*	*13.2*
Medical Technology	17	6	0	*23*	*73.9*	*26.1*	*0.0*
Vehicles	14	14	18	*46*	*30.4*	*30.4*	*39.1*
Other Manufacturing	22	19	3	*44*	*50.0*	*43.2*	*6.8*
Water/Environment	88	47	14	*149*	*59.1*	*31.5*	*9.4*
Construction	37	8	5	*50*	*74.0*	*16.0*	*10.0*
Services	*782*	*165*	*102*	*1049*	*74.5*	*15.7*	*9.7*
Wholesale Trade	70	14	8	*92*	*76.1*	*15.2*	*8.7*
Retail Trade	15	3	0	*18*	*83.3*	*16.7*	*0.0*
Accommodation/Restaurants	2	2	1	*5*	*40.0*	*40.0*	*20.0*
Transportation	82	35	19	*136*	*60.3*	*25.7*	*14.0*
Telecommunications	12	4	2	*18*	*66.7*	*22.2*	*11.1*
Publishing/Media	49	14	3	*66*	*74.2*	*21.2*	*4.5*
Information Technology/Services	99	14	7	*120*	*82.5*	*11.7*	*5.8*
Banks/Insurance	51	17	27	*95*	*53.7*	*17.9*	*28.4*
Real Estate/Rental&Leasing	31	17	7	*55*	*56.4*	*30.9*	*12.7*
Technical Commercial Services	165	18	8	*191*	*86.4*	*9.4*	*4.2*
Other Commercial Services	205	25	18	*248*	*82.7*	*10.1*	*7.3*
Other Services	1	2	2	*5*	*20.0*	*40.0*	*40.0*
Mining, Agriculture	*24*	*10*	*2*	*36*	*66.7*	*27.8*	*5.6*
Total	*1489*	*557*	*275*	*2321*	*64.2*	*24.0*	*11.8*

Table A.10: Composition of the original sample

Sector/Branch	Small	Medium	Large	Total	Small	Medium	Large
	Number of Firms				Percentage (in Sector/Branch)		
Industry	*1866*	*900*	*398*	*3164*	*59.0*	*28.4*	*12.6*
Food/Beverages/Tobacco	182	64	29	*275*	*66.2*	*23.3*	*10.5*
Textiles/Clothing	129	65	10	*204*	*63.2*	*31.9*	*4.9*
Wood	67	26	6	*99*	*67.7*	*26.3*	*6.1*
Paper	38	26	10	*74*	*51.4*	*35.1*	*13.5*
Printing	77	22	8	*107*	*72.0*	*20.6*	*7.5*
Chemicals	72	38	29	*139*	*51.8*	*27.3*	*20.9*
Pharmaceuticals	22	14	12	*48*	*45.8*	*29.2*	*25.0*
Rubber/Plastics	72	50	27	*149*	*48.3*	*33.6*	*18.1*
Non-metallic Minerals	80	39	16	*135*	*59.3*	*28.9*	*11.9*
Basic Metals	33	34	18	*85*	*38.8*	*40.0*	*21.2*
Fabricated Metal Products	230	100	20	*350*	*65.7*	*28.6*	*5.7*
Machinery & Equipment	111	97	70	*278*	*39.9*	*34.9*	*25.2*
Electrical Equipment	87	41	22	*150*	*58.0*	*27.3*	*14.7*
Electronic & Optical Products	178	71	23	*272*	*65.4*	*26.1*	*8.5*
Repair/Installation	117	20	16	*153*	*76.5*	*13.1*	*10.5*
Medical Technology	61	18	4	*83*	*73.5*	*21.7*	*4.8*
Vehicles	41	39	44	*124*	*33.1*	*31.5*	*35.5*
Other Manufacturing	69	42	5	*116*	*59.5*	*36.2*	*4.3*
Water/Environment	200	94	29	*323*	*61.9*	*29.1*	*9.0*
Construction	132	16	7	*155*	*85.2*	*10.3*	*4.5*
Services	*2194*	*504*	*268*	*2966*	*74.0*	*17.0*	*9.0*
Wholesale Trade	225	51	22	*298*	*75.5*	*17.1*	*7.4*
Retail Trade	38	8	3	*49*	*77.6*	*16.3*	*6.1*
Accommodation/Restaurants	5	7	1	*13*	*38.5*	*53.8*	*7.7*
Transportation	267	103	47	*417*	*64.0*	*24.7*	*11.3*
Telecommunications	44	10	7	*61*	*72.1*	*16.4*	*11.5*
Publishing/Media	132	35	10	*177*	*74.6*	*19.8*	*5.6*
Information Technology/Services	226	44	19	*289*	*78.2*	*15.2*	*6.6*
Banks/Insurance	132	39	53	*224*	*58.9*	*17.4*	*23.7*
Real Estate/Rental&Leasing	101	45	38	*184*	*54.9*	*24.5*	*20.7*
Technical Commercial Services	428	58	18	*504*	*84.9*	*11.5*	*3.6*
Other Commercial Services	585	98	48	*731*	*80.0*	*13.4*	*6.6*
Other Services	11	6	2	*19*	*57.9*	*31.6*	*10.5*
Mining, Agriculture	65	21	3	*89*	*73.0*	*23.6*	*3.4*
Total	*4257*	*1441*	*676*	*6374*	*66.8*	*22.6*	*10.6*

Austria

Table A.11: Composition of original sample, valid questionnaires and response rates by industry

Sector/Branch	NACE R2	Original sample	Valid questionnaires	Response rate
Industry		2722	248	9.1
Food/Beverages/Tobacco	10,11,12	270	25	9.3
Textiles/Clothing	13,14,15	261	17	6.5
Wood	16	124	12	9.7
Paper	17	85	11	12.9
Printing	18	92	4	4.3
Chemicals	19,2	119	10	8.4
Pharmaceuticals	21	45	3	6.7
Rubber/Plastics	22	132	14	10.6
Non-metallic Minerals	23	139	15	10.8
Basic Metals	24	106	17	16.0
Fabricated Metal Products	25	208	19	9.1
Machinery & Equipment	28	230	30	13.0
Electrical Equipment	27	128	13	10.2
Electronic & Optical Products	26	136	15	11.0
Repair/Installation	33	87	6	6.9
Medical Technology	325	8	0	0.0
Vehicles	29,30	164	8	4.9
Other Manufacturing	31,321,322,323,324, 329	198	17	8.6
Water/Environment	36,37,38,39	190	12	6.3
Construction	41,42,43	496	46	9.3
Services		3873	245	6.3
Wholesale Trade	45,46	525	40	7.6
Retail Trade	47,95	315	11	3.5
Accommodation/Restaurants	55,56	282	12	4.3
Transportation	49,50,51,52,79	428	19	4.4
Telecommunications	53,61	76	7	9.2
Publishing/Media	58,59,60	214	5	2.3
Information Technology/Services	62,63	227	9	4.0
Banks/Insurance	64,65,66	344	33	9.6
Real Estate/Rental&Leasing	68,77,81	350	20	5.7
Technical Commercial Services	71,72	219	31	14.2
Other Commercial Services	69,70,73,74,78,80,82	756	47	6.2
Personal Services	96	137	11	8.0
Total		7091	539	7.6

Note: Due to the small number of available questionnaires response rates are presented here only by industry and not by industry-specific firm size classes.

Table A.12: Composition of the original sample

Sector/Branch	Small	Medium	Large	Total	Small	Medium	Large
	Number of Firms				Percentage (in Sector/Branch)		
Industry	1514	825	383	2722	55.6	30.3	14.1
Food/Beverages/Tobacco	134	98	38	270	49.6	36.3	14.1
Textiles/Clothing	204	48	9	261	78.2	18.4	3.4
Wood	69	39	16	124	55.6	31.5	12.9
Paper	37	32	16	85	43.5	37.6	18.8
Printing	68	20	4	92	73.9	21.7	4.3
Chemicals	69	38	12	119	58.0	31.9	10.1
Pharmaceuticals	27	7	11	45	60.0	15.6	24.4
Rubber/Plastics	61	49	22	132	46.2	37.1	16.7
Non-metallic Minerals	66	53	20	139	47.5	38.1	14.4
Basic Metals	49	33	24	106	46.2	31.1	22.6
Fabricated Metal Products	64	106	38	208	30.8	51.0	18.3
Machinery & Equipment	55	104	71	230	23.9	45.2	30.9
Electrical Equipment	68	44	16	128	53.1	34.4	12.5
Electronic & Optical Products	61	44	31	136	44.9	32.4	22.8
Repair/Installation	77	6	4	87	88.5	6.9	4.6
Medical Technology				8			
Vehicles	99	34	31	164	60.4	20.7	18.9
Other Manufacturing	147	38	13	198	74.2	19.2	6.6
Water/Environment	152	31	7	190	80.0	16.3	3.7
Construction	212	217	67	496	42.7	43.8	13.5
Services	2121	1241	511	3873	54.8	32.0	13.2
Wholesale Trade	148	266	111	525	28.2	50.7	21.1
Retail Trade	149	94	72	315	47.3	29.8	22.9
Accommodation/Restaurants	149	109	24	282	52.8	38.7	8.5
Transportation	238	134	56	428	55.6	31.3	13.1
Telecommunications	56	14	6	76	73.7	18.4	7.9
Publishing/Media	166	40	8	214	77.6	18.7	3.7
Information Technology/Services	153	54	20	227	67.4	23.8	8.8
Banks/Insurance	159	116	69	344	46.2	33.7	20.1
Real Estate/Rental&Leasing	219	92	39	350	62.6	26.3	11.1
Technical Commercial Services	148	61	10	219	67.6	27.9	4.6
Other Commercial Services	466	211	79	756	61.6	27.9	10.4
Personal Services	70	50	17	137	51.1	36.5	12.4
Total	3847	2283	961	7091	54.3	32.2	13.6

Weighting schemes

We apply a multiple weighting of data in order to correct for possible selection bias as well as divergences from sample structure and from total firm population respectively, particularly when the individual data are aggregated at industry or sector level. The single weights used are as follows:

- *Sample structure*: we define a weight w_{hi} for every observation (firm) i belonging to cell h (h=1,…N; N =102):

  $w_{hI} = 1/f_H = 1/(n_H/N_H) = N_H/n_H$

  with: f_H : drawing rate of cell h; n_H :number of firms in cell h in the sample; N_H :number of firms in cell h in the total population

- Non-response rate: we define for every firm i in the cell h a weight $1/r_{hi}$, where r_{hi} is the probability that firm i responds to the questionnaire.

- Weight = w_{hI} $1/r_{hi}$

This weight is calculated separately for each country and is used for all calculations in this descriptive study.

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