Energy

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POLICY REPORT ON ENERGY EFFICIENCY POTENTIAL IN THE SERVICE SECTOR

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Introduction

In the framework of the State Research Programme "Energy", the project "The pathway to energy efficient future for Latvia (EnergyPath)" is being implemented. According to the defined project tasks, milestones, fulfilment of sector-specific criteria and project schedule, a mid-term project deliverable include the submission of a **policy report on energy efficiency potential in the service sector.** The deliverable consists of the assessment of the technical and economic energy efficiency potential in the sector, as well as of the recommendations on the acquisition of energy-efficiency potential.

In the first phases of the project implementation, a detailed model on the energy efficiency potential assessment was developed. The model includes the utilization of a top-down and bottom-up approach, in order to obtain objective and in-depth investigation on energy utilization efficiency and identify the existing obstacles and opportunities for the long-term energy efficiency improvement in the sector. The previously defined model is intended to be used to assess the energy efficiency potential in industrial, service, agriculture, transport and the household sectors. Taking into account the specifics of each sector and the data availability, the previously determined model was adjusted and adapted for the service sector. A simplified methodology for the energy efficiency potential assessment for the service sector is reflected in Figure 1.

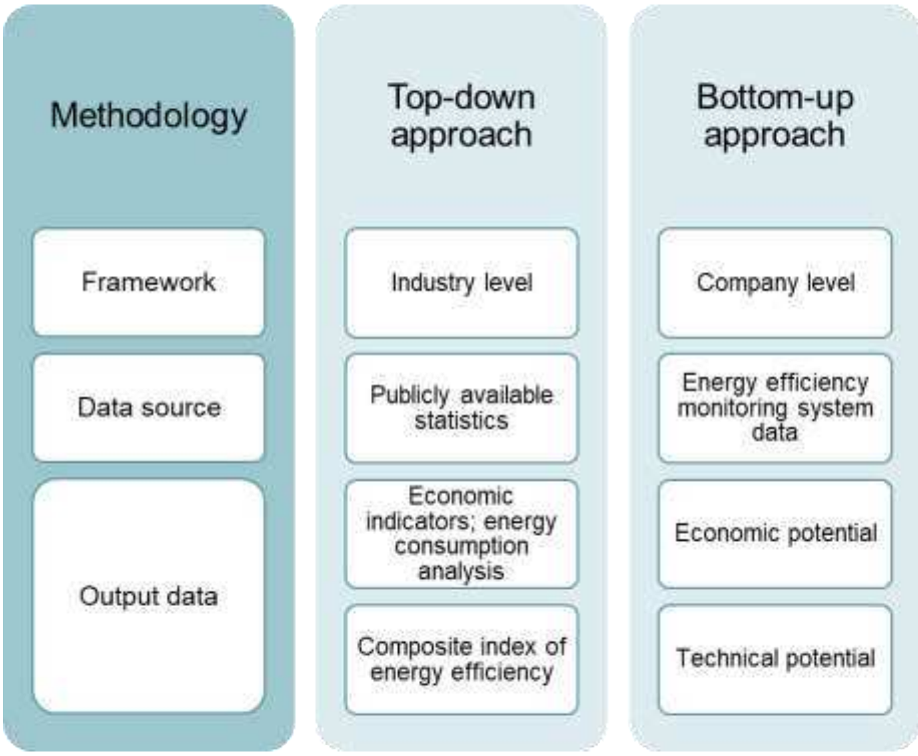


Fig. 1. Methodology for energy efficiency potential assessment in the service sector.

Within the framework of the developed methodology, an in-depth data analysis on the energy efficiency performance of the service sector companies is carried out in accordance with the national Energy Efficiency Law. This includes the analysis of the energy efficiency monitoring system data from which the economic and technical energy efficiency potential is determined. In addition, a new and innovative model is presented, the energy efficiency composite index for the services sector. The composite index results provide valuable insights on the sectorial differences among the service sub-sectors and identifies significant aspects for energy efficiency improvements in each sub-sector. A top-down data acquisition approach was used in order to analyze the economic and structural indicators, as well as the energy consumption tendencies in the service sector. The policy report in this document is structured into chapters according to the above-mentioned methodology framework.

1. THE IDENTIFICATION OF ENERGY EFFICIENCY POTENTIAL

Within the framework of this chapter, an in-depth analysis of Energy Efficiency Monitoring System (EMS) data is carried out for the service sector. The data was obtained directly from the Ministry of Economics of the Republic of Latvia, the access to the database was provided based on the mutually signed agreement between the Riga Technical University (RTU) and the Ministry of Economics (ME). All companies in the database were sorted according to the NACE Rev. 2 classification, which allowed accurate data processing to be carried out by selecting only representative companies of the sector concerned. The data analysis includes several steps and the sources of the data used, which are summarized in Table 1-1.

Table 1 -1.

Chapter content and corresponding data sources used within the methodological framework

No.	Research activity	Data source
1.	Collection and analysis of energy efficiency monitoring system data for the service sector	• Energy Efficiency Monitoring System (EMS) program data provided by the Ministry of Economics (ME) • Central Statistical Bureau (CSB) energy flow accounts (ENG200) data (CSB, n.d. - b) • Eurostat air emissions accounts by NACE Rev. 2 classification (env_ac_ainah_r2) data (Eurostat, 2020a)
2.	Assessing the economic energy efficiency potential for the service sector	
3.	Identification of technical energy efficiency potential for the service sector by applying the Swedish benchmark	• Technical energy efficiency potential benchmarks from Paramonova and Thollander (2016) publication on energy savings potential in Sweden (Paramonova & Thollander, 2016)

Energy consumption data for the service sub-sectors were derived from the Physical energy flow accounts (ENG200) of the Central Statistical Bureau (CSB), as it provides detailed statistical data on energy consumption in the distribution of service sub-sectors. The data are taken for the year 2017, which is the most recent available data in the database at the time the study is carried out. The unit of measure of energy resources and electricity consumption from TJ is converted to GWh in order to ensure a common representation of units of measure in the study and to make data comparable among each other.

For the statistical data processing and analysis, a mathematical model was developed in MS Excel software that performed all the calculations of the study and produced all the displayed graphics, charts, and tables.

For the investigation of service sector data, the commercial and public sectors are selected according to NACE Rev. 2 classification. (CSP, n.d.-f), summarized in Table 1-2. The corresponding group was based on the number of entries in the database in each of the sectors.

Given that a sufficient number of company records in the Energy Efficiency Monitoring System (EMC) database were not available for some of the sectors, these sectors were combined with one of the sectors with a similar type of economic activity. According to the table, this applies to the sectors such as professional, scientific and technical activities (M) and the activities of administrative and support service activities (N), which were jointly combined. As well as the sectors public administration and defense; compulsory social security (O) and education sector (P), which were also grouped together accordingly. In addition, the sectors of arts, entertainment and recreation (R) and the activities of extraterritorial organizations and bodies (U) were combined together due to the number of limited records in each.

Table 1-2.

Service sector grouping according to NACE Rev. 2 classification (CSP, n.d.-f)

NACE code	Name of the sub-sector
E	Water supply; sewage, waste management and remediation activities
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M-N	Professional, scientific and technical activities; administrative and support activities
O-P	Public administration and defense; compulsory social security; education
Q	Human health and social work activities
R, U	Arts, entertainment and recreation; activities of extraterritorial organizations and bodies

1.1. Energy efficiency monitoring system data analysis

In the database of the Energy Efficiency Monitoring System (EMS) program, from available data for 1490 companies, 783 companies corresponded to the classification of the services sector, which was further used in the energy consumption data analysis of the sector.

According to the information contained in the database, a collection of data was carried out for the service sub-sectors on the following indicators:

- number of companies submitting one of the following three documents: energy audit report, ISO 14001 or ISO 50001 certificate
- reported energy savings in 2016 and 2017
- projected annual energy savings
- breakdown of achieved and projected savings by type of energy efficiency activities
- investment by the companies in energy efficiency activities in 2016 and 2017
- electricity consumption in 2016, 2017, 2018

Given that all the aspects mentioned above, with the exception of electricity consumption data, include information on the consumption of all energy sources (including electricity and heat), the description of this sub-chapter is structured in two parts. The first subparagraph provides a description of data analysis for all energy sources. The second part only reflects only electricity consumption data.

1.1.1. Achieved and projected savings

In total, the projected annual energy savings in the services sector amounts to 66,2 GWh, or 0,75% of total energy consumption in 2017. Service sector companies reported 56,4 GWh of energy savings in 2016, representing 0,64% of total energy consumption in the sector. The relatively large savings were achieved despite the fact that only 24 service companies indicated the savings achieved. One company operating in the information and communication sector has reported 14,4 GWh of savings and four other service sector companies have identified savings ranging from 6,8 to 9 GWh in each. In 2017, 81 companies identified energy savings, representing a total of 27,6 GWh, or 0,31% of total energy consumption in the services sector. Unlike observed in the industry data analysis, much of the energy savings was already achieved by service-sector companies in the first years of the program, in total for 2016 and 2017 reporting 84 GWh of energy savings. Figure 1-1. illustrates the energy savings achieved and projected by the service sector.

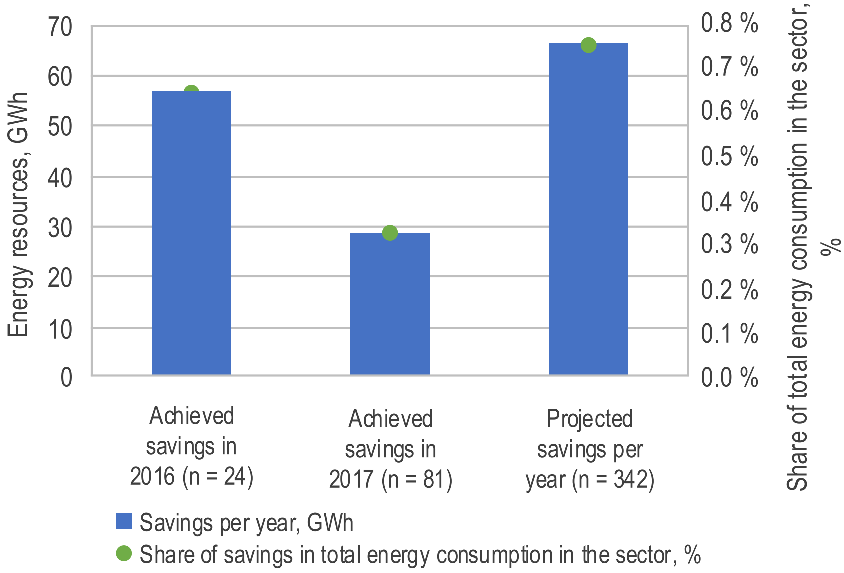


Fig. 1-1. Achieved and projected savings in the service sector in the national EMS program (CSP, n.d.-b).

According to EMS data, energy audits were submitted by 245 service sector companies, ISO 50001 certificates were submitted by 103 companies, and ISO 14001 with supplementation was submitted by 8 service sector companies. Accordingly, data is summarized in Table 1-3.

Table 1-3.

Summary of submitted energy audits, ISO 50001 and ISO 14001 (with supplementation) certificates by the service sector companies

	Quantity
Submitted energy audits	245
Submitted ISO 50001 certificates	103
Submitted ISO 14001 (with supplementation) certificates	8

In 2016, 18 service sector companies indicated the amount of investment made in energy efficiency activities, which together amounted to EUR 8 233 297. In 2017, 63 companies in the services sector invested a total of EUR 4 790 281 for the implementation of energy efficiency activities. It can be seen that in 2016, nearly twice as much funds were invested in the sector as in 2017. The savings achieved in 2016 were also reported to be twice as high as observed in 2017.

Figure 1-2. reflects the energy savings dependency of the service sector companies on the invested resources. It includes the data on the identified achieved energy savings in 2016 and 2017 for the respective EMS companies, which had also indicated the resources invested in the implementation of energy efficiency activities. There is no strong correlation observed between the invested funds and achieved energy savings. One company that operates in the information and communication service sector identified the largest investments made in 2016, i.e. EUR 6,2 million, therefore achieving the largest energy savings of 14,3 GWh. Due to an incomplete dataset, for other companies it was not possible to identify precisely which energy efficiency activities resulted in the corresponding achieved energy savings.

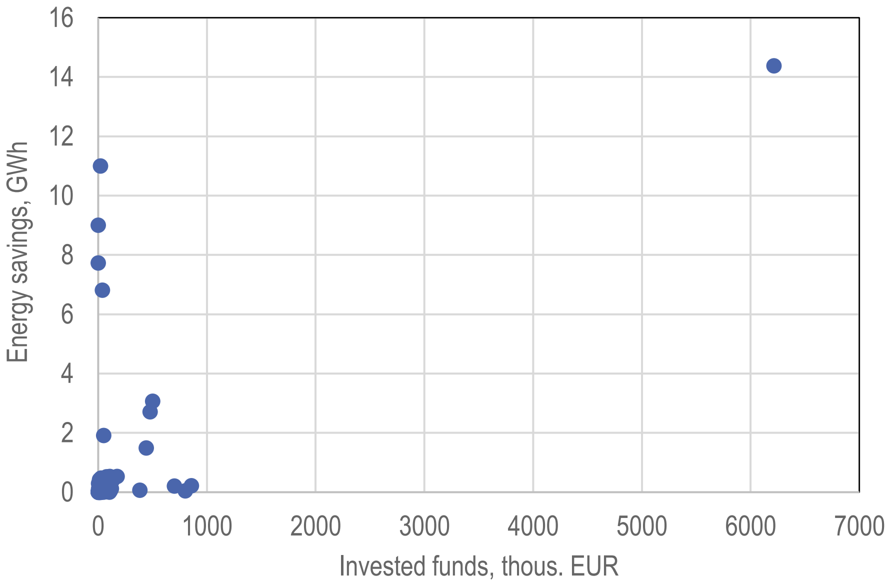


Fig. 1-2. Dependency of the energy savings achieved on investments in 2016 and 2017 for EMS service companies.

For a relatively small number of EMS service companies, it was possible to obtain information on their specific costs (EUR/MWh), which measures the amounts of euro being invested to achieve energy savings of 1 MWh. In 2016 in total 17 and in 2017 in total 58 service sector companies had full information on both the invested funds and the energy savings achieved. This information and data was necessary in order to determine the specific costs of the implementation of energy efficiency activities. During the data processing, one data outliner was detected and excluded from the dataset and further analysis of the results (i.e. in 2017 one company reported an investment of EUR 1 and savings of 116,26 MWh).

Table 1-4 summarizes statistical information on the dynamics of the specific costs of the service sector companies. Following the information provided in the table, it can be observed that the total specific costs are highly distributed in both 2016 and 2017. The lowest specific costs from the 2016 and 2017 data were EUR 0,09/MWh reported by one company in the arts, entertainment and recreation sector (R), where an investment of EUR 802 was identified and a savings of 9 GWh was achieved.

On the other hand, the largest specific costs of EUR 15 325,67/MWh were indicated by one company which operates in a wholesale and retail; the automotive and motorcycle repair sector (G), which reported 800 thous. EUR of investment, but only 52,2 MWh of achieved savings in 2017. It should be noted that potential savings are expected in the upcoming years, in the case if the investments were made at the end of the financial accounting year. Or the company concerned did not reflect full factual information on the savings achieved. In the event of such data being observed, the Ministry of Economics needs to carry out a more in-depth study, allowing the companies concerned to clarify the data or provide justification for reporting such values by explaining the factors and circumstances that affected the situation.

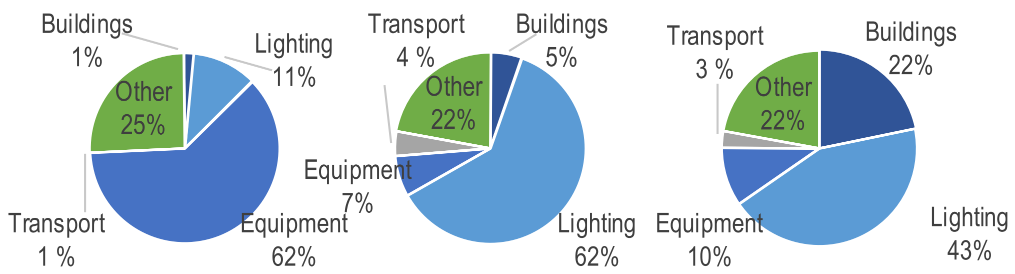
Table 1-4.

Specific costs for the EMS companies operating in the services sector in 2016 and 2017

	2016	2017
Number of records	17	58
Minimum value, EUR/MWh	0,09	1,95
Maximum value, EUR/MWh	504,66	15325,67
Data range	504,57	15323,72
Average value, EUR/MWh	174,21	1626,28
Standard deviation	158,84	3072,48
Median, EUR/MWh	141,86	359,96

The average value of the specific costs in 2016 was 174,21 EUR/MWh, in 2017 it was equal to 1 626,28 EUR/MWh. This means that in the year 2016 in order to achieve the energy savings of 1 MWh on average 174,21 EUR had to be invested. The same relationship is also true for the values of the year 2017. Moreover, the median equals 141,86 EUR/MWh in 2016 and 359,96 EUR/MWh in 2017.

Figure 1-3. reflects the distribution of already achieved and projected savings by major energy consumption groups. Significant differences in the distribution of consumption can be observed. In 2016, majority or 62% of actual energy savings were achieved thanks to improvements in equipment, 25% in other activities, 11% in lighting measures, 1% improvements in buildings and 1% in transport. In 2017, the majority or 62%, consisted of the implementation of lighting improvement activities, 22% of other activities, 7% improvements in equipment, 5% in building and 4% in transport. From data analysis it can also be seen that, given that in 2017 the majority of energy efficiency activities were targeted at switching or improving lighting systems, the corresponding total savings achieved in 2017 were significantly lower than in 2016, where more investments in equipment were made, which generally have a much higher effect on improving energy efficiency.



(a) Actual savings in 2016; (b) Actual savings in 2017; (c) Projected savings

Fig. 1-3. Actual and projected energy savings in the service sector by type of implemented energy efficiency activity.

Following the breakdown of projected savings by the implemented energy efficiency activities, it can be observed that in the services sector the majority or 43% of the savings is expected to be achieved through investment in the lighting activities. Following with the improvements in the energy efficiency of buildings with projected 22%, another 22% by the implementation of other activities, 10% by improvements in the energy efficiency of equipment and 3% by increasing the energy efficiency in transport. This breakdown also partly explains why the overall projected savings of the sector are expected to be relatively small. Measures to improve energy efficiency in lighting systems represent a significantly lower proportion of the total savings compared to improvements in the energy efficiency of equipment. Consequently, it can be concluded that in the services sector companies also choose to meet the minimum legislative requirements by investing in support measures, such as switching lighting, rather than by investing in energy efficient equipment, which would help to achieve a much higher percentage of savings. It is important to note that a large number of companies have not fully identified information in the breakdown by implemented energy efficiency activities, which does not allow to obtain objective assessment of savings across the projected and already implemented energy efficiency measures. More specifically, the data in several places at the projected savings or achieved savings is not accurate, or the breakdown by energy efficiency activity group is not sufficiently reflected. This aspect needs to be taken into account when conclusions are made on the overall evaluation of the EMS programme. In the future, it would be valuable to address existing gaps in the data monitoring system in order to provide more complete and accurate information.

1.1.2. Electricity consumption trends

On average, the total electricity consumption in the EMS service sector companies is equal to 1 452 GWh over the last three years. Figure 1-4. reflects the total electricity consumption of the services sector in the EMS programme.

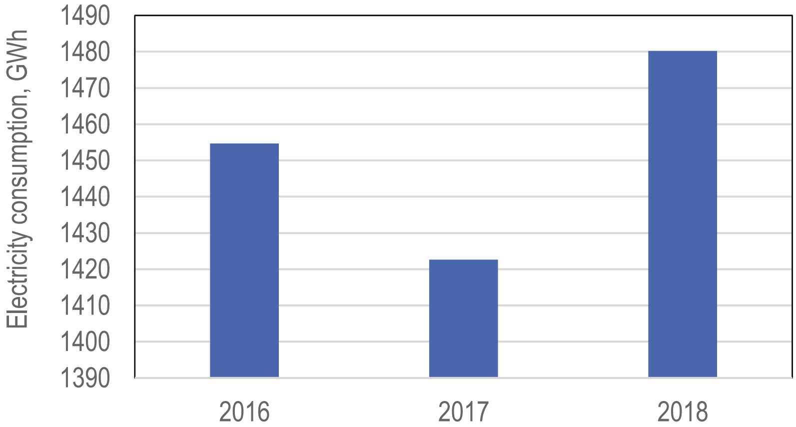


Fig. 1-4. Total electricity consumption of the services sector in the EMS program.

In 2016, the total electricity consumption between EMS companies in the service sector amounted to 1 454,7 GWh, in 2017 it was equal to 1 422,6 GWh and in 2018 equal to 1 480,2 GWh. It can be seen that total electricity consumption decreased by 31,3 GWh in 2017 compared to the year 2016. However, a significant increase was observed in 2018, with a total electricity consumption in the sector increasing by 59,3 GWh compared to 2017 consumption figures.

Figure 1-5. reflects the electricity consumption of the service sector in the EMS program, broken down by service sub-sectors. The most pronounced electricity consumption among the sub-sectors is observed in a real estate sector (L), where the average electricity consumption over the last three years was 678,4 GWh. The second largest electricity consumer in the service sector is wholesale and retail trade; repair of motor vehicles and motorcycles sector (G), which on average accounts for 334,3 GWh of electricity consumption. The lowest electricity consumers in the EMS program are the public administration and defense; compulsory social security (O) and education (P) sectors, which together account for an average of 11,5 GWh and the financial and insurance activities sector (K), representing 13,8 GWh of electricity consumption.

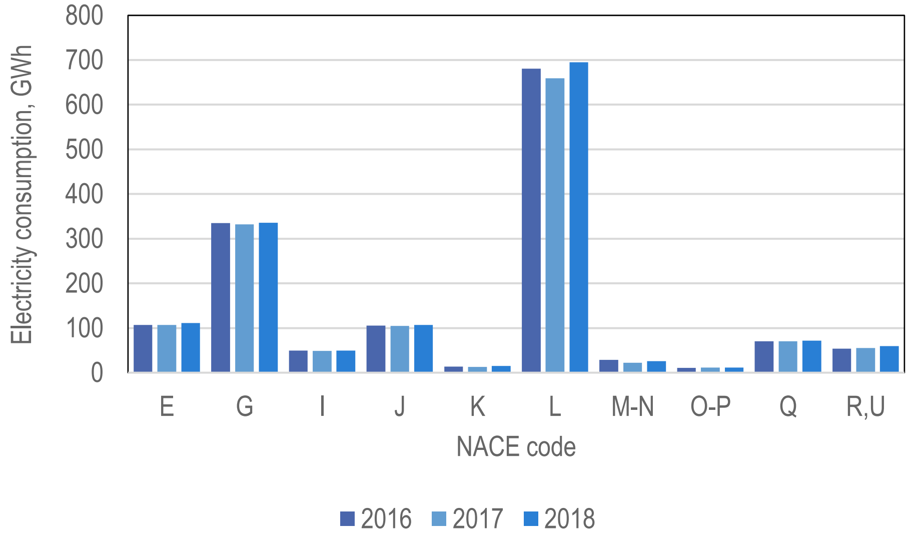


Fig. 1-5. Electricity consumption of the service sector in the EMS program, broken down by sub-structure according to NACE Rev. 2 classification.

Figure 1-6. reflects the share of electricity consumption by EMS companies from total electricity consumption in the service sector in 2017. The figure reflects the percentage of the electricity consumption for the year 2017, as indicated by the companies of the EMS program, from the total electricity consumption of the sector in 2017 and, accordingly, the proportion of the electricity consumption of other companies. It can be observed that for the majority of sectors the largest proportion is composed from the EMS program companies or large companies and/or large electricity customers. However, in the sub-sectors such as public administration and defense; compulsory social security sector (O) and education sector (P), professional, scientific and technical activities sector (M) and administrative and support activities (N), accommodation and food service activities sector (I) is observed the opposite, where EMS program companies account for the lowest share, with 3,7%, 38,3% and 44,4% respectively of the total electricity consumption in the sector.

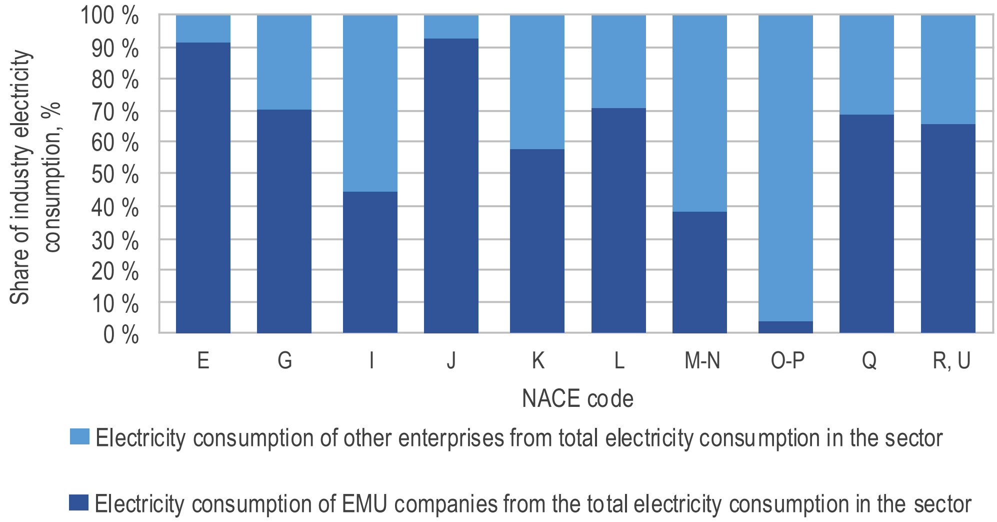


Fig. 1-6. The share of electricity consumption of EMS program service sector comapnies from the total electricity consumption in the sector broken down by the sub-sectors.

Table 1-5. shows tendencies in electricity consumption in the services sector for enterprises under the EMS program. When assessing trends in total electricity consumption, it can be seen that the majority of the services sub-sectors decreased overall electricity consumption in 2017 compared to 2016. In 2018, however, all sectors in the service sector showed an increase in total electricity consumption. The public sector, which includes public administration and defense; compulsory social security sector (O) and education sector (P), as well as the human health and social work activities (Q) sectors showed an increase in electricity consumption in both 2017 and 2018. Also, the arts, entertainment and recreation sector (R) and the activities of extraterritorial organizations and bodies (U) showed an increase in electricity consumption in both years.

Table 1-5.

Electricity consumption tendencies by the EMS program companies operating in the services sector broken down by the sub-sectors (CSP, n.d.-b)

NACE code	Annual electricity consumption, GWh			Trend, GWh		Electricity consumption in the sector in 2017, GWh (CSP, n.d.-b)	Share of electricity consumption by EMS companies,%
	2016	2017	2018	2017 - 2016	2018 - 2017		
E	107,2	106,6	111,4	↓ 0,6	↑ 4,8	116,6	91,4%
G	334,9	332,1	335,8	↓ 2,9	↑ 3,7	471,7	70,4%
I	49,2	48,4	49,6	↓ 0,8	↑ 1,2	108,9	44,4%
J	105,6	104,7	107,0	↓ 0,9	↑ 2,3	112,6	93,0%
K	13,4	13,0	15,2	↓ 0,4	↑ 2,2	22,4	57,9%
L	680,9	658,9	695,3	↓ 22,0	↑ 36,4	924,4	71,3%
M-N	28,5	22,5	25,5	↓ 6,0	↑ 3,0	58,7	38,3%
O-P	11,0	11,6	11,8	↑ 0,7	↑ 0,1	318,4	3,7%
Q	70,3	70,5	71,9	↑ 0,1	↑ 1,4	102,3	68,9%
R,U	53,7	55,1	59,2	↑ 1,4	↑ 4,1	84,0	65,6%
Total	**1454,7**	**1423,4**	**1482,6**	↓ **31,3**	↑ **59,3**	**2320,0**	**61,4%**

1.2. Identification of the economic energy efficiency potential

The assessment of the economic energy efficiency potential in the services sector is carried out below in the breakdown of the sub-sectors. Together, in the services sector, 342 companies identified projected savings that are taken as the basis for further analysis of data. Table 1-6. summarizes statistical data from EMS on service sector enterprises in the sector that have indicated projected savings.

Table 1-6.

Summary of the statistics on the indicated projected energy savings by service sector companies of EMS program

	Total number of records in EMS	Number of records indicating projected savings	Share of the total number of records indicating the projected savings,%
E	40	34	85%
G	154	81	53%
I	45	23	51%
J	24	16	67%
K	21	13	62%
L	376	98	26%
M-N	36	11	31%
O-P	7	5	71%
Q	41	36	88%
R,U	39	25	64%
Total	**783**	**342**	**44%**

From Table 1-6. it can be observed that in most sub-sectors more than half of the EMS companies have indicated projected savings. However, in the sector, real estate operations (L), with the largest number of EMS companies, only 26% have indicated projected savings. Similarly, in the professional, scientific and technical activities sector (M) and administrative and support activities (N), only 31% of EMS companies have indicated projected savings. As a result, together in the services sector from all EMS companies, 44% have indicated projected savings. The savings identified by these companies are used below for the calculation of the overall energy efficiency potential of the sector.

Table 1-6. draws attention to the fact that, in general, there are many missing data in the EMS that do not allow for a more accurate and appropriate calculation of the energy efficiency potential of the sector. Less than half of the service companies have identified the expected savings, which will also have a significant impact on the overall conclusions on the energy efficiency potential of the sector, which will be demonstrated in further calculations. It is important to take this aspect into account, bearing in mind that if all companies had indicated their expected savings, the sector's potential would also be reported in much higher values in the calculations compared to the ones derived from existing data.

1.2.1.Assessment of the energy savings

A more in-depth analysis of data was carried out following the selection of data on the EMS companies in the service sector that indicated the projected energy savings. Table 1-7. summarizes the savings and energy efficiency potential of each service sub-sector, calculated as the ratio of the estimated energy savings from the total energy consumption of the sector in 2017.

In total the largest projected energy savings per year have been recorded by wholesale and retail trade; repair of motor vehicles and motorcycles sector (G), and real estate sector (L) with savings of 17,89 GWh and 17,10 GWh per year, respectively. The third largest projected energy savings is foreseen in the human health and social work activities sector (Q), which indicated 10 GWh of annual savings.

Table 1-7.

Summary of projected energy savings in the services sub-sectors

NACE code of the sub-sector	Estimated annual energy savings, GWh	Energy consumption in the sub-sector in 2017, GWh (CSP, n.d.-b)	Estimated annual energy savings,% of the total energy consumption of the sub-sector
E	3,50	596,06	0,6%
G	17,89	2471,04	0,7%
I	3,48	239,79	1,5%
J	4,96	172,08	2,9%
K	1,20	53,97	2,2%
L	17,10	2206,37	0,8%
M-N	4,67	440,80	1,1%
O-P	1,46	1908,84	0,1%
Q	10,00	490,76	2,0%
R,U	1,98	200,99	1,0%
Total	**66,24**	**8780,71**	**0,75%**

According to relative estimates of the savings, the highest values have been identified by the sub-sectors such as information and communication services sector (J) with 2,9% savings, financial and insurance activities sector (K) with 2,2% savings and human health and social work activities sector (Q) with 2,0% of projected energy savings relative to the total energy consumption of the sector.

Public sub-sectors such as public administration and defense; compulsory social insurance; education (O-P) reported relatively lower energy consumption savings, indicating 0,1% projected energy savings per year from the total energy consumption of the sub-sector, which together account for 1,46 GWh. However, it is important to note that, in the O-P sub-sectors, only 5 organizations in the EMS system have indicated data on projected annual energy savings, which have a corresponding impact on the overall estimated economic energy efficiency potential of the sub-sectors. Figure 1-7. reflects the economic energy efficiency potential in each of the sub-sections of the services sector.

The average economic energy efficiency potential of the services sector is equal to 1,3%. Only 4 sectors show potential figures above the sector's average. In addition to the information and communication services sector (J), financial and insurance activities sector (K) and the health and social care sector (Q), the accommodation and food service sector (I), with a value of 1,5%, has achieved an economic energy efficiency potential above the average grade.

The values below the average have reached most of the sub-sectors. The lowest values are observed in sub-sectors such as public administration and defense; compulsory social security; education (O-P) with a value of 0,1%, water supply; sewage, waste management and remediation activities sector (E) of 0,6%, wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) of 0,7% and real estate operations sector (L) of 0,8%.

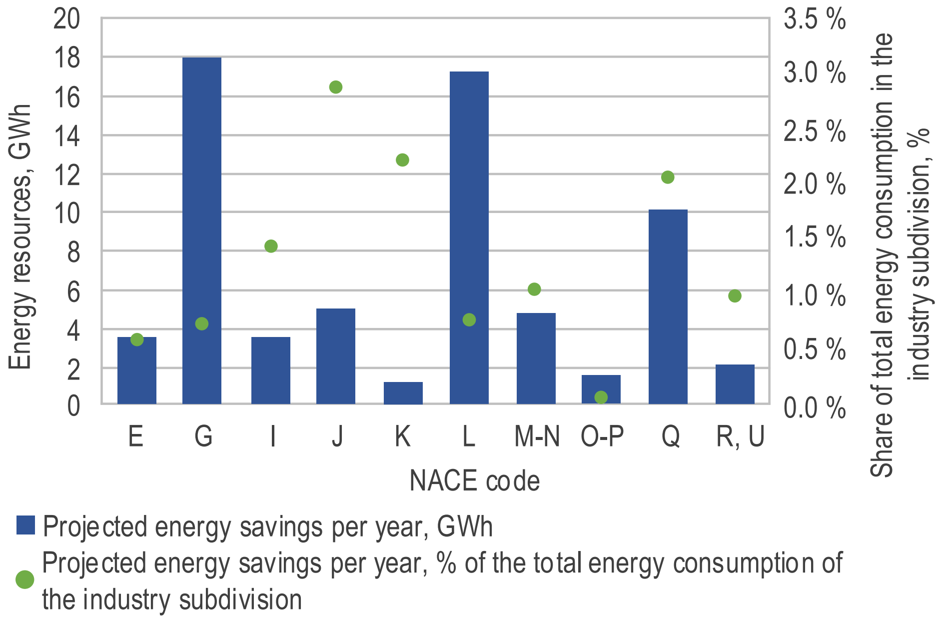


Fig. 1-7. Economic energy efficiency potential in the services sub-sectors.

1.2.2. Assessment of CO_2 reductions

On the basis of the results of the economic energy efficiency potential for the service sector, it was possible to calculate the potential for CO_2 emission reduction. The results are summarized in Table 1-8. According to publicly available statistics, a specific amount of CO_2 emissions is distributed to each sector in the service sector. According to available information on CO_2 emissions volumes, the CO_2 intensity for each sector is calculated as the proportion between the emission volumes in tons and the amount of energy resources consumed per MWh per year. The projected savings in CO_2 emissions are calculated below. It is derived from the CO_2 intensity and projected annual energy savings.

Table 1-8.

Summary of the calculated CO_2 savings in the service sub-sectors

NACE code	Projected annual energy savings, GWh	CO_2 emissions, tons (2017) (Eurostat, 2020a)	CO_2 intensity, tons/MWh	Estimated annual CO_2 savings, tons
E	3,50	37 887	0,06	222,54
G	17,89	278 059	0,11	2 012,92
I	3,48	18 521	0,08	268,76
J	4,96	10 732	0,06	309,45
K	1,20	6 192	0,11	137,15
L	17,10	111 810	0,05	866,68
M-N	4,67	87 770	0,20	930,59
O-P	1,46	107 074	0,06	81,99
Q	10,00	40 853	0,08	832,47
R,U	1,98	10 095	0,05	99,45
Total	**66,24**	**708 993**	**-**	**5 762,01**

The total projected CO_2 emission savings in the service sector equals to 5 762,01 tons per year, representing approximately 0,81% of the total CO_2 emissions generated by the service sector in total. The largest reduction in CO_2 emissions is projected to be achieved in a wholesale and retail trade; repair of motor vehicles and motorcycles sector (G), which is the largest CO_2 pollutant in the industry. The sector is expected to achieve 2 013 tonnes of CO_2 savings, representing 40% of the industry's total projected savings. The second largest reduction in CO_2 is expected to be achieved in the sector group: professional, scientific and technical activities sector (M) and administrative and support activities (N) with an estimated total CO_2 savings of 931 tons per year. For the public sector, which includes public administration and defense; compulsory social security sector (O), education sector (P) and the health and social care sector (Q), a total annual CO_2 savings of 914,46 tons is expected.

Figure 1-8. graphically reflects the expected CO_2 emission reductions, broken down by service sub-sectors, as indicated in Table 1-8.

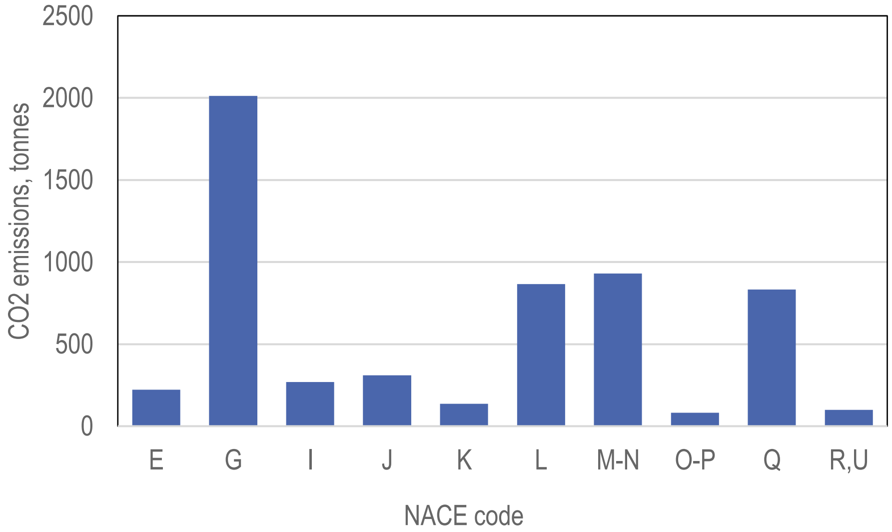


Fig. 1-8. Projected CO_2 savings in the service sub-sectors.

1.3. Identification of technical energy efficiency potential by benchmark

Taking into account that, unfortunately, the services sector does not have available data for energy audits in an electronic form, it is not possible for the sector to calculate and identify the exact technical energy efficiency potential. The absence of these data significantly limits the methodology and model for calculating the developed energy efficiency potential. Even though it is not possible to determine the technical energy efficiency potential of the service sector in Latvia, the technical potential benchmark for the service sector is demonstrated as part of this sub-section of the report, which could be achieved as a result of the best available technologies and non-existent barriers.

Paramonova and Thollander (2016) study assess energy efficiency potential in almost all sectors of Swedish economy, by analysing energy audits data from similarly introduced energy efficiency improvement programs in Sweden. The study identifies technical energy efficiency potential grades also for service sub-sectors (Paramonova & Thollander, 2016). These values may be considered as benchmarks for the technical energy efficiency potential of the relevant sectors of the service sector. Thus, the identified values in Paramonova and Thollander (2016) study are applied in the context of Latvia and calculations are made for technical energy efficiency potential for service sub-sectors following the Swedish benchmark values (Paramonova & Thollander, 2016). The calculation values are summarized in Table 1-9. It is important to note that the information presented in the table does not reflect the current state of the technical energy efficiency potential in Latvia, but it gives an insight into how much potential the industry can theoretically be in the light of the Swedish best practice.

Table 1-9.
Identification of technical energy efficiency potential for service sub-sectors using the Swedish benchmark

NACE kods	Energy consumption in the service sub-sectors 2017, GWh (CSP, n.d.-b)	CO_2 intensity, tons/MWh (Eurostat, 2020a)	Values of technical energy efficiency potential by Swedish benchmark,%	Energy consumption savings by applying the Swedish benchmark, GWh	Reduction of CO_2 emissions by applying the Swedish benchmark, tons
E	596,06	0,06	3%	17,88	1072,91
G	2471,04	0,11	20%	485,97	53456,83
I	239,79	0,08	30%	71,94	5754,96
J	172,08	0,06	5%	8,60	516,24
K	53,97	0,11	2%	1,08	118,73
L	2206,37	0,05	27%	595,72	30188,73
M-N	440,8	0,20	25%	108,31	21662,17
O-P	1908,84	0,06	26%	496,30	29777,90
Q	490,76	0,08	22%	107,97	8637,38
R,U	200,99	0,05	23%	46,23	2311,39
Total	**8780,71**	**-**	-	**1940,00**	**153497,24**

After applying the Swedish benchmark to each of the sub-sectors, the theoretical values of the technical energy efficiency potential for each of the service sub-sectors were calculated. The total estimated technical energy efficiency potential of the sub-sectors, or theoretical potential energy savings by the application of Swedish benchmark is equal to 1 940 GWh. The highest savings, i.e. 595,72 GWh, were calculated in the real estate sector (L). High savings were also calculated in the public administration and defense sector; compulsory social security; education (O-P) sector with a value of 496,30 GWh and wholesale and retail; automotive and motorcycle repair sector (G) with a value of 485,97 GWh. The values in each of the sub-sectors are illustrated in Figure 1-9.

It can be observed that the benchmark values for technical energy efficiency potential are significantly higher than those obtained in the of economic energy efficiency potential in the preceding sub-chapter. The calculated energy savings by the application of the Swedish benchmark are by 1 873,75 GWh higher than the total projected energy savings reported by the EMS service sector companies. It indicates that the sector is able to achieve much higher amounts of energy savings in the long term.

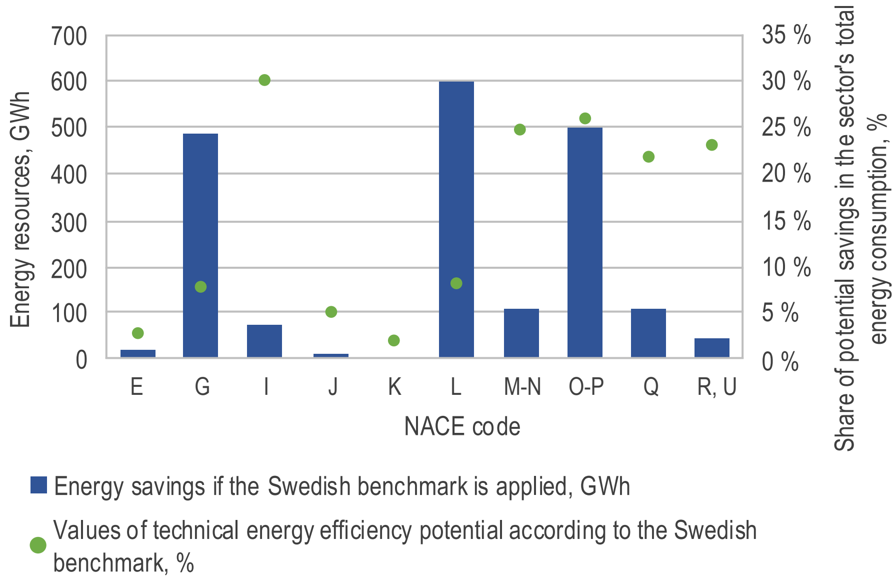


Fig. 1-9. Technical energy efficiency potential values by applying the Swedish benchmark.

The estimated CO_2 savings show even more significant savings potential for the reduction of emissions in the service sector. In total, it was estimated that the technical CO_2 reduction potential in the services sector was 153 497,24 tons (when Swedish benchmark was applied). In Figure 1-10. the potential for CO_2 reduction in each of the sub-sectors of the service sector is reflected.

The largest CO_2 reduction was calculated for the wholesale and retail trade; repair of motor vehicles and motorcycles sector (G), reaching 53 456,83 tons of CO_2 emissions. Given the sector's high CO_2 intensity and energy consumption, a higher potential CO_2 reduction value was obtained. Real estate operations sector (L) represent the second largest CO_2 reductions of 30 188,73 tons. High amount of CO_2 savings, or 29 777,9 tons, were also calculated for the public administration and defense sector; compulsory social security; education (O-P) sector. professional, scientific and technical activities sector and administrative and support activities sector (M-N) represents the fourth largest estimated CO_2 savings potential of 21 662,17 tons.

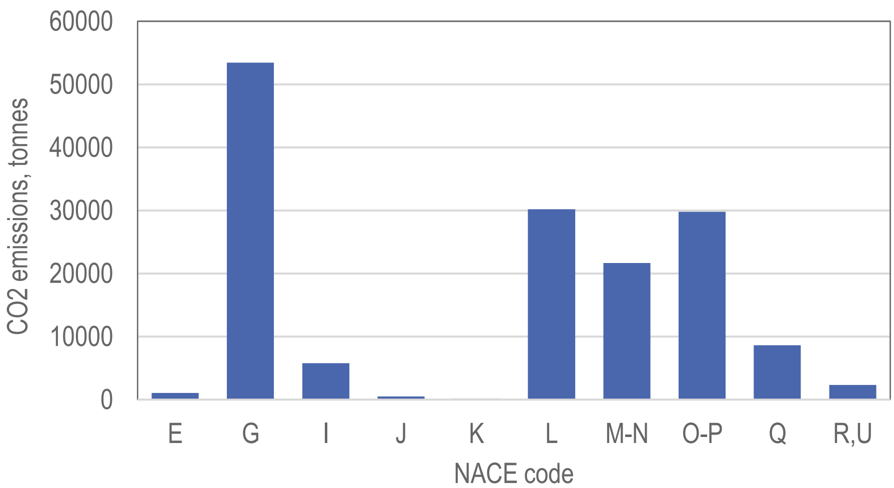


Fig. 1-10. CO_2 reduction potential by the application of the Swedish benchmark.

Following the calculations made in this chapter section, it can be concluded that the Swedish benchmark provides significantly higher energy savings potential for all service sub-sectors, with the exception of financial and insurance sector (K). The total estimated technical energy efficiency potential by applying the Swedish benchmark represents 22% of the total energy consumption of the sector. By comparison, according to economic energy efficiency potential estimates, the projected energy savings of EMS companies in the services sector represent only 0,75% of the total energy consumption in the sector. Therefore, in the long term, the sector can achieve much higher energy savings and there is a need to implement policy mechanisms and instruments to stimulate their achievement.

2. ENERGY EFFICIENCY COMPOSITE INDEX

This chapter demonstrates the methodology for developing the energy efficiency composite index for the service sector and the results obtained for each of the sub-sectors. The composite index methodology is based on the use of a bottom up approach, which includes an assessment of the performance of energy efficiency at sectoral level. The composite index methodology is an unprecedented concept in energy efficiency assessment studies. It is based on the use and adaptation of the approach to the concept of sustainable development, which leads to the development and demonstration of an innovative model for comparing the performance of the energy performance of the sectors, which makes it possible to identify significant differences between the different sectors of the sector that should be taken into account by policy makers.

The content of the chapter is structured as follows: A detailed description of the methodological approach is presented, including explanations and assumptions for the steps of the composite index calculation. The results of the Service Sector Energy Efficiency Composite Index are presented below, which includes a description of the results for each sub-index of the energy efficiency dimensions.

2.1. Description of the methodological framework

As part of this study, the energy efficiency index (EEI) is defined as a measure that evaluates the performance of energy efficiency in the various sub-sectors of the Latvian service sector. It consists of a number of independent indicators that are grouped into appropriate dimensions. Composite index construction and calculation process is a composite process involving the selection of appropriate methodological approaches and calculation procedures (Lemke & Bastini, 2020; Mazziotta & Pareto, 2013). The model developed in this study is based on the methodological approach for the development of a composite index previously used in both - scientific publications (Barrera-Roldán & Saldívar-Valdés, 2002; Krajnc & Glavič, 2005; Mazziotta & Pareto, 2013; Razmjoo et al., 2019), and in world-leading international organizations such as the United Nations, the European Commission, the World Economic Forum and others (Gilijum et al., 2017; Lemke & Bastini, 2020). The methodology for the energy efficiency composite index developed in the service sector is summarized and illustrated in Figure 2-1. The development of the composite index includes the 6 major calculation steps, which are also described in the sub-sections below, respectively.

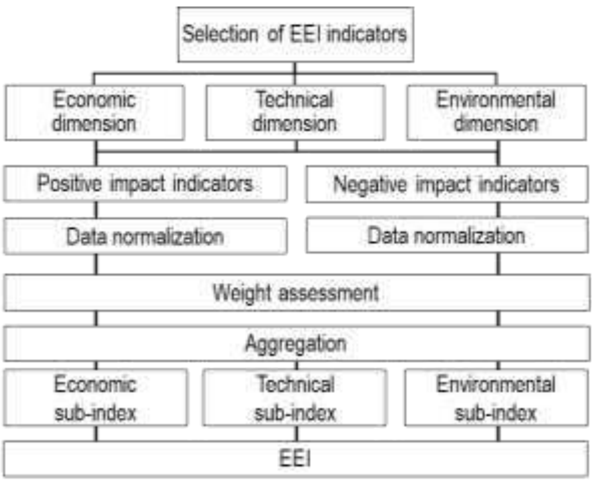


Fig. 2-1. Key stages in the development of an energy efficiency composite index.

2.1.1. Selection of the indicators

Initially, appropriate indicators are selected which have a significant impact on the energy efficiency level of the sector. Based on the availability of data, 9 indicators were included for 11 different sub-sectors of the Latvian services sector.

The development of an energy efficiency composite index for the service sector included sub-sectors of the services sector (commercial and public sector) for which complete datasets were available for all indicators identified and defined, that were integrated into the composite index according to Table 2-1. Following the collection of available data, the energy efficiency composite index for the service sector included the following NACE Rev. 2 divisions according to the statistical classification of economic activities (CSP, n.d.-f):

- E: Water supply; waste water, waste management and recovery
- G: Wholesale and retailing; repair of motor vehicles and motorcycles
- I: accommodation and catering services
- J: Information and communication services
- L: Real estate operations
- M: Professional, scientific and technical services
- N: Activities of administrative and service services
- O: Public administration and defense; compulsory social security
- P: Education
- Q: Health and Social Care
- S: Other services

Since the activities of NACE divisions for financial and insurance activities (K), art, entertainment and recreation (R) and outdoor organizations and institutions were not available for a number of indicator values, they were not included in the overall overview and development of the composite index. This is not considered to be a significant limitation of the model, since these NACE divisions do not represent a significant proportion of the energy consumption of the sector, but rather, on the contrary, these sectors are relatively small energy consumers. More specifically, together they consume less than 3% of total energy consumption in the services sector (CSP, n.d.-b).

Most of the data were collected from the Central Statistical Bureau (CSB) and Eurostat, which are publicly available databases. All data were selected for 2017, which for most of the selected indicators were the most up-to-date data at the time of the study. Three key dimensions of sustainable energy efficiency, economic, technical and environmental, were identified. Table 2-1. summarizes the breakdown of indicators in dimensions and the data sources used.

2.1.2. Classification of indicators in dimensions

The economic dimension reflects the ability of the sector to generate competitive turnover and added value to the energy consumption. In addition, the dimension provides for an energy cost factor measured by the energy taxes paid by the sector relative to the output volume. The viability of the economic dimension plays an important role in the overall energy efficiency composite index to assess whether the economic contribution of the sector to the economy is able to offset the amounts of energy consumed. Sectors with high economic performance are less dependent on the amount and cost of energy consumed. A high value of the economic dimension points to the economic and financial stability of the sector, potentially leading to a more sustainable implementation of energy management practices.

Table 2-1.

Selected indicators, classification into dimensions and data sources used

Dimension	Indicator	Indicator calculation	Data source	Data code and reference
Economic dimension	Value added per energy use	Value added, in thousands EUR/energy resources consumed, GWh	CSB	IKG10_050 (CSP, n.d.-c); ENG200 (CSP, n.d.-b)
	Output per energy use	Output of goods and services, in thousands EUR/energy resources consumed, GWh	CSB	IKG10_050 (CSP, n.d.-c); ENG200 (CSP, n.d.-b)
	Energy taxes per generated turnover	Taxes on energy, thousands EUR/output of goods and services, in thousands EUR	Eurostat; CSB	env_ac_taxind2 (Eurostat, 2020b) ; IKG10_050 (CSP, n.d.-c)
Technical dimension	Investment per energy use	Gross capital investment in tangible goods (EUR thousand)/energy resources consumed, GWh	CSB	IVG060 (CSP, n.d.-d); SBG010 (CSP, n.d.-h); ENG200 (CSP, n.d.-b)
	Share of ISO 14001 registered companies	Number of companies registered in ISO 14001/total number of companies	ISO/TC; CSB	ISO Survey (ISO Survery, 2018); SRG020 (CSP, n.d.-i)
	Energy consumption per employee	Energy resources consumed, GWh/total number of employees	CSB	ENG200 (CSP, n.d.-b); NBG191 (CSP, n.d.-g); SRG030 (CSP, n.d.-j)
Environ-mental dimension	Greenhouse gas intensity	Greenhouse gases, tonnes/value added, thousand EUR	Eurostat; CSB	env_ac_ainah_r2 (Eurostat, 2020a); IKG10_050 (CSP, n.d.-c)
	Share of fossil energy resources	Fossil energy products consumed, GJ/total energy products consumed, GJ	CSB	ENG200 (CSP, n.d.-b)
	CO_2 productivity	Output of goods and services, in thousands EUR/CO_2 emissions, tonnes	CSB; Eurostat	IKG10_050 (CSP, n.d.-c); env_ac_ainah_r2 (Eurostat, 2020a)

The technical dimension includes a number of key aspects related to the technical capacity and performance of the sector in relation to sustainable energy management. It includes indicators such as investments in tangible goods to the amount of energy consumed, the consumption of energy resources per employee and the number of companies that have implemented the ISO 14001 standard relative to the total number of companies in the sector. Investments made in material goods per unit of energy resources consumed reflect the sector's activity to invest in buildings, equipment, materials that potentially also improve overall energy efficiency. The more investment is made, the more modern and resource-efficient solutions are being put in place. Total energy consumption in the services sector is closely linked to the total number of employees, particularly office buildings, where most of the energy is consumed by lighting, office and IT equipment, air conditioning, building heating and other activities. It is therefore essential to include structural characteristics of the sector by analysing the relationship between the amount of energy consumed and the total number of employees. The number of ISO 14001 registered companies relative to the total number of companies in the sector reflects the sector's progress towards a sustainable environment and resource management. The number of service sector companies that have implemented ISO 14001 standards were collected from the official ISO database that is publicly available. In available public data on the ISO 50001 registered companies in the services sector, there were detected missing values and lack of information, however, more detailed data were available on ISO 14001, which included direct data on the number of services sector organisations implementing the ISO 14001 standard. It is assumed that if the organization has implemented the ISO 14001 standard, it maintains well developed environmental management practice and is more likely to set environmental targets for reducing energy consumption and improving energy efficiency in the long term. Based on the available data from the energy efficiency monitoring system (EMS) that was provided by the Ministry of Economy, a number of service companies have been actively implementing ISO 50001 since 2016, i.e. in 2018, a total of 103 companies. In the further composite index studies EMS data could be used in order to obtain more specific data on share of ISO 50001 registered companies in the services sector.

The environmental dimension reflects the sector's economic activity's impact on the ecosystem and the atmosphere, determined by the values of three different indicators, which are included in the environmental dimension. As one indicator, the greenhouse gas intensity calculated as the total volume of greenhouse gases produced by the sector in tonnes with respect to the added value created in monetary units is calculated. Another indicator is also included: the percentage of fossil energy use calculated as the total amount of fossil energy products used in the sector as a share of total energy products consumed. As an additional indicator, the environmental dimension includes CO_2 productivity, calculated as output of goods and services generated in the sector against CO_2 emissions in tonnes. Sectors with lower environmental impacts are more sustainable on an operational basis and show higher energy efficiency performance.

2.1.3. Impact assessment of indicators

When indicators are identified and grouped into dimensions, the impact of each indicator on improving energy efficiency is assessed. All selected indicators are divided into two groups, those with a positive impact and those with a negative impact on the industry's target of achieving higher energy efficiency.

In order to determine whether the indicator is positively or negatively correlated with the overall energy efficiency composite index (EEI), the impact of each indicator on the EEI is assessed based on the following rule of thumb. The indicator has a positive impact on the EEI if its increasing value contributes to improving energy efficiency. On the other hand, the indicator has a negative impact on the EEI if its increasing value prevents energy efficiency gains (Krajnc & Glavič, 2005). Following the assessment made for each indicator, the following impact categories were summarized:

Indicators with a positive impact on the energy efficiency composite index: value added per energy use, output per energy use, investment per energy use, share of ISO 14001 registered companies, CO2 productivity.

Indicators with a negative impact on the energy efficiency composite index: energy taxes per generated turnover, energy consumption per employee, greenhouse gas intensity, share of fossil energy resources.

2.1.4. Data normalization

Classification of indicators based on their impact on EEI is necessary as it determines further data normalization methodology that is a crucial element in the overall construction of EEI. The data normalization stage converts the units of measurement of each indicator into a common scale, therefore allowing to compare all the different indicator values among each other (Krajnc & Glavič, 2005). After the data normalization procedure, all indicator values are compatible and can be aggregated into a common dimension sub-index value and final composite energy efficiency index (EEI) value. There are a number of methodological approaches for data normalization, such as standardisation, ranking, scaling (min-max normalization), distance-based normalization, etc.(Mazziotta & Pareto, 2013). As part of this study, a min-max data normalization technique is used since it is recommended for use in relative comparison studies. (Mazziotta & Pareto, 2013). Min-max data normalization scales each indicator in a range from 0 to 1, where 0 is the lowest value, while 1 is the highest value. The min-max data normalization technique is used in a number of internationally recognized composite index application reports, such as the European Commission's *eco-innovation index*, the United Nations' *human development index* and others.

The value of each indicator is normalized using the following equations. Indicators for which positive effects on EEI were identified are normalized using the equation 1.

$$I_N^+ = \frac{I_{act} - I_{min}}{I_{max} - I_{min}} \qquad (1)$$

Indicators for which a negative impact on EEI was identified are normalized using the equation 2.

$$I_N^- = 1 - \frac{I_{act} - I_{min}}{I_{max} - I_{min}} , \qquad (2)$$

where I_N^+ means an indicator with a positive impact on an EEI, I_N^- means an indicator with a negative impact on an EEI, I_{act} is the actual value of an indicator in a given sector, I_{max} is the maximum value of an indicator among all sectors, I_{min} is the minimums value of an indicator among all sectors.

2.1.5. Allocation of weights

After the indicator values have been normalized, for each indicator an appropriate impact weight category is assigned to the indicator's impact to a particular dimension sub-index. Several weighing techniques are available, such as equal weighting, expert weighting, analytical hierarchy process (AHP) method (Mazziotta & Pareto, 2013). In order to obtain a maximum objective representation of the results, a method of equal weighting was applied within the scope of this study. It is used frequently in a variety of sustainable development studies that highlight the equal importance of each indicator and its impact on the composite index. (Barrera-Roldán & Saldívar-Valdés, 2002).

For the development of the service sector energy efficiency composite index, an equal weight category is assigned to each indicator and to each dimension. It is assumed that all indicators and dimensions included have the same impact on EEI as all indicators are interlinked and create synergies that have a common impact on the sector's energy efficiency performance.

2.1.6. Aggregating indicators

The final calculation step for the development of the index includes an aggregation of normalized and weighted indicators. Initially, indicators are combined using equation 3.

$$I_D = \sum w \times I_N^+ + \sum w \times I_N^- , \ w = \frac{1}{n_I} , \quad (3)$$

where I_D is the value of the sub-index of the corresponding dimension, w is the category of impact weight assigned to the indicator, I_N^+ and I_N^- are the values of the positive or negative impact indicators of each dimension, n_I is the total number of indicators in the dimension.

The final value of the energy efficiency composite index is obtained by combining the values of the sub-indices of each dimension with the weight category assigned to them. The calculation step is done using equation 4.

$$EEI = \sum w \times I_D , \ w = \frac{1}{n_D} , \quad (4)$$

where EEI is an energy efficiency composite index, w is the weight category assigned to each of the dimensions, n_D is the number of dimensions.

The energy efficiency composite index reflects the aggregation of the three-dimensional sub-indices. By assigning an equal weight category for each dimension, the dimensions are integrated into a single composite index. Figure 2-2. shows the basic hierarchy of the service sector energy efficiency composite index.

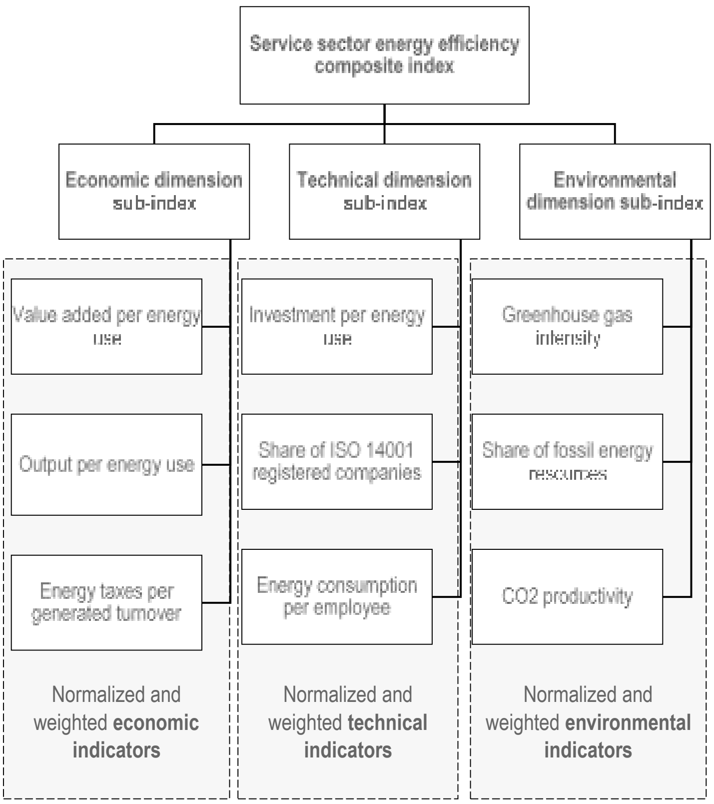


Fig. 2-2. General Hierarchy of the service sector energy efficiency composite index.

2.2. Analysis of the results

The results of the energy efficiency composite index are analysed and described separately, broken down by the resulting values in each of the dimension sub-indices. Then followed by the analysis of the results for the final service sector composite index that integrates all the values of the dimension sub-indices.

2.2.1. Economic dimension sub-index

According to the economic dimension sub-index results (see Figure 2-3.) it may be observed that the water supply, waste water, waste management and recovery sector (E) obtained the lowest possible value of 0. This is due to the fact that the sector achieved the lowest values in each of the indicator grades of the economic dimension compared to the other sectors included in the service sector composite index.

In more detail, the sector generates the lowest value added per unit of consumed energy and its output value per unit of consumed energy was also the lowest among the other compared sectors. Furthermore, when considering the energy costs that is measured by energy taxes per generated turnover, it can be observed and concluded that the sector accounts for the largest share of energy taxes paid. Thus, the sector accounts for the largest share of energy taxes paid, thus showing higher energy costs compared to other services sectors.

The poor performance of this sector in the economic dimension is explained by the fact that this sector is more industrial than others, as well as more capital and technology intensive, therefore also highly dependable on the energy resources. The sector is not able to generate competitive economic contribution to the overall economy due to its structure since it provides public utilities that in general cannot generate high profit margin on the revenue. The sector's characteristics are also reflected in the results of the economic dimension sub-index, with the sector getting the lowest values in each of the indicator values.

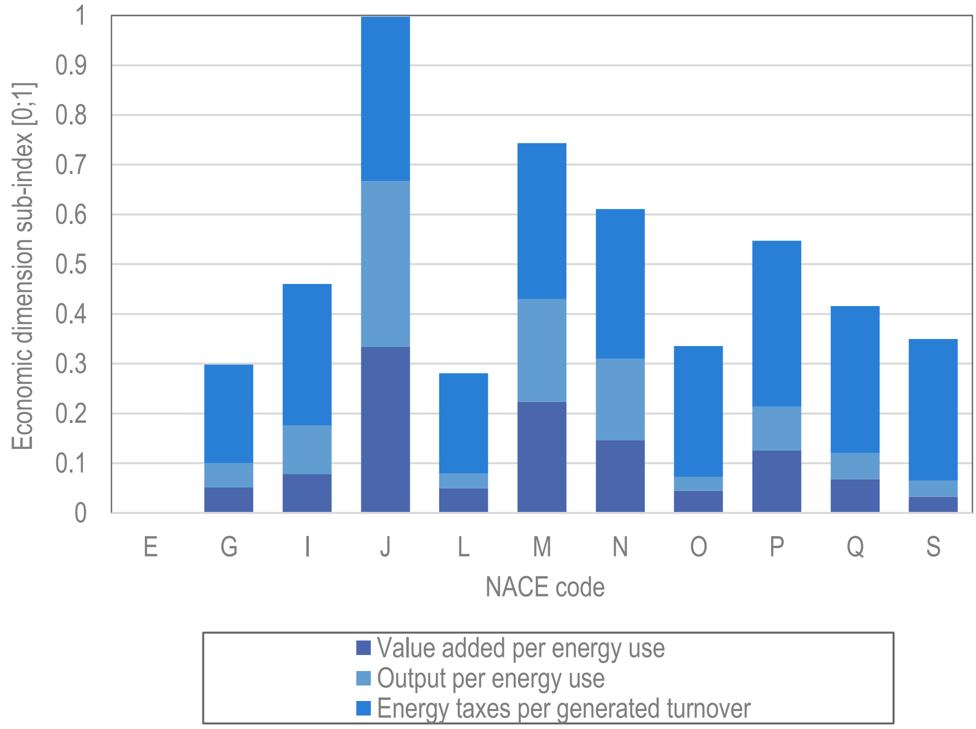


Fig. 2-3. Economic dimension sub-index.

The absolute leader in the economic dimension is the information and communication services sector (J), which gained almost the maximum value of 1. This shows that the sector is able to deliver high economic value added by consuming relatively small amounts of energy resources. As well as spending significantly lower energy costs, which in turn has a positive impact on the profitability of the sector's companies. The relatively high performance of the economic dimension sub-index shall also be reported by the professional, scientific and technical services sector (M) of a value of 0,74, the operational sector of administrative and service services (N) of a value of 0,61 and the education sector (P) of a value of 0,55.

On the other hand, lower economic dimension sub-index values, i.e. values below 0,5 for service sub-sectors such as accommodation and catering services sector (I) of 0,46, health and social care sector (Q) of value 0,42 and other services sector (S) of value 0,35. The lowest values were obtained by public administration and defense; compulsory social security sector (O) with 0,34, wholesale and retail trade; automotive and motorcycle repair services sector (G) with 0,30 and the water supply, sewage, waste management and recovery sector (E) mentioned above, with the lowest possible value of 0.

The overall economic dimension sub-index indicators between the sectors are relatively volatile and represent a large range of dimensional results. The smallest dimension value is 0, while the highest is 1. This indicates that there are significant differences between the economic value created and the energy unit consumed between the sub-sections of the service sector. The average value of the economic dimension sub-index is 0.46. Annex 1 summarises the values of the economic dimension indicator for each sector.

2.2.2. Technical dimension sub-index

Results of the technical dimension (see Figure 2-4.) are more homogeneous compared to the results seen in the economic dimension. The total results of the technical dimension sub-indices between the sectors range from 0,01 to 0,7 and the average value between the sectors is 0,43. Compared to the economic dimension sub-index, none of the sectors have reached a maximum value of 1 in the technical dimension.

The highest value of 0,7 was achieved by the information and communication services sector (J). The sector was the leader in terms of achieved values also in the economic dimension sub-index. The second highest value in the technical dimension was reached by the activities of administrative and service services sector (N) that reached a value of 0.63. Both sectors performed well in the indicator values for energy consumption per employee and investments made per unit of energy consumed. The third highest value of the technical dimension sub-index was achieved in the water supply, sewage, waste management and recovery sector (E), where its value reached 0,53. This sector shows the highest figures in the number of ISO 14001 registered companies, as a result it significantly increased the total value of the technical dimension.

The lower technical dimension values were observed in the other services sector (S) with a value of 0,01, real estate operations (L) with a value of 0,29 and the health and social insurance sector (Q) with a value of 0.,2. The health and social insurance sector (Q) had a competitive indicator value for energy consumption per employee that indicated that the sector consumes relatively less energy per employee. However, the sector performed poorly in the indicator figures for number of ISO 14011 registered companies and in the investments made per unit of the energy consumed. As a result, it ranked the sector in low positions in the overall technical dimension sub-index.

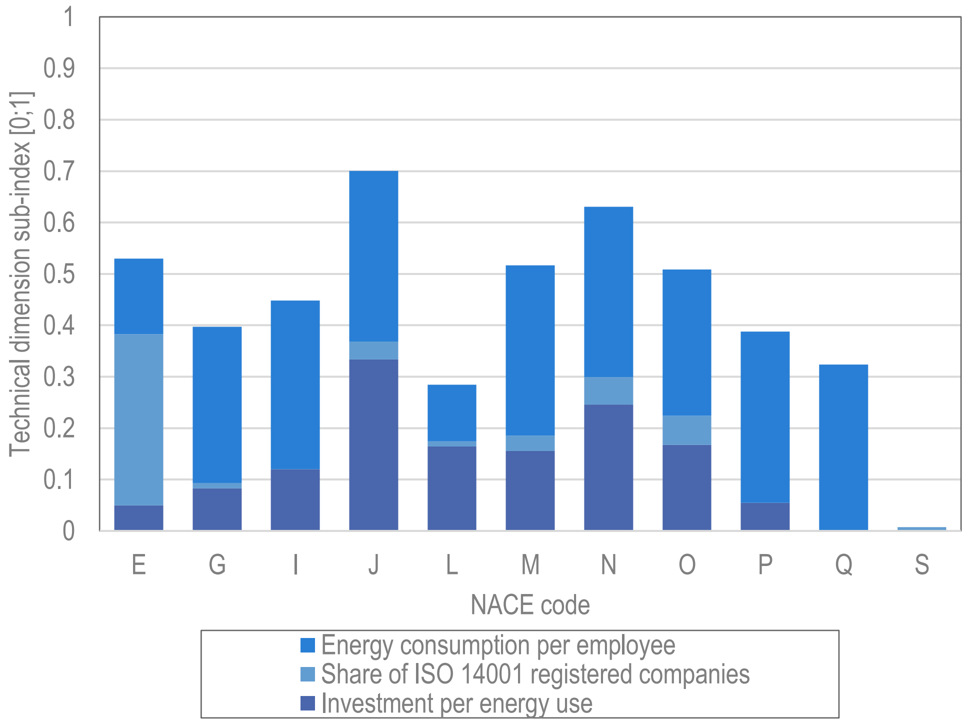


Fig. 2 4 Technical dimension sub-index

In other public service sectors, the values of the mid-level technical dimension sub-index were observed. The total value of public administration and defense; compulsory social insurance sector (O) is 0,32, represented by a relatively competitive indicator for energy consumption per employee. The sector also showed average investments per unit of energy consumed and a low share in the number of companies registered in ISO 14001. The total technical dimension sub-index of the education sector (P) is valued at 0,39. The sector shows a high indicator for energy consumption per employee, indicating that there is not a high amount of energy per employee compared to the other sectors in the service sector. However, investments made on energy consumption are relatively low. Nor were registered ISO 14001 organisations identified in this sector, which could not contribute to the value of the sub-index of the overall technical dimension. Annex 2 summarizes the values of the technical dimension indicators for each service sector.

2.2.3. Environmental dimension sub-index

The values of the environmental dimension sub-indices (see Figure 2-5) range between 0,26 and 0,96. The average value of the dimension is equal to 0,58, which is the highest average value among all three dimensions. There are no sectors in the environmental dimension that received the lowest possible sub-index grade (i.e. a score of 0). The highest values for the environmental dimension sub-index were observed for the information and communication services sector (J) with a value of 0.96 and for the education sector (P) with a value of 0,84. Both sectors showed high levels of CO_2 productivity and low rates of fossil energy use and greenhouse gas intensity. Thus, ranking both sectors in high positions in each of the explanatory indicators for the environmental dimension.

The lowest environmental dimension sub-index was observed in the water supply, sewage, waste management and recovery sector (E), which reached a value of 0,26. The sector got the lowest values in the CO_2 productivity indicator and the greenhouse gas intensity indicator, which indicates that compared to other service sectors in the scope of this study. The sector produces much higher amounts of emissions that the generated added value and turnover cannot compensate at the adequate level. The sector gained average value in the fossil energy indicator, which shows sector's relatively low share of fossil energy use from total energy products.

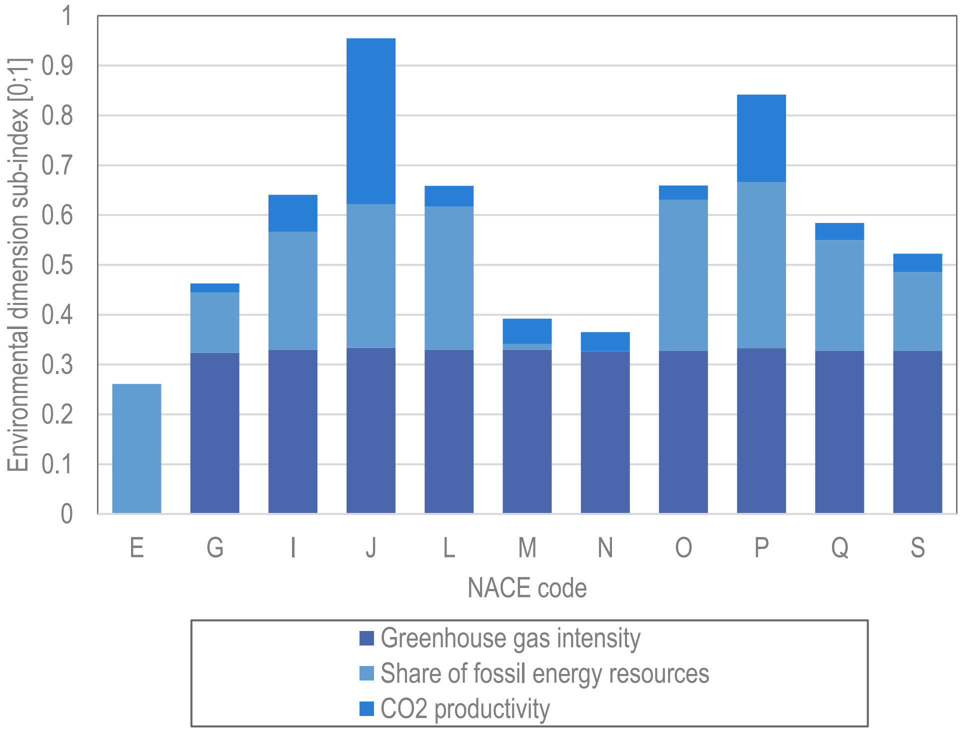


Fig. 2-5. Environmental dimension sub-index.

Low environmental dimension sub-index values were also observed in sectors such as the professional, scientific and technical services sector (M) with a value of 0,39 and the operating sector of administrative and service services (N) with a value of 0,37. In both sectors, low values were observed at indicators such as CO_2 productivity and the use of fossil energy. This shows that both sectors have a relatively high share of fossil energy resources from the consumption of total energy products. Statistics from the CSB energy flow accounts show that both sectors consume relatively high levels of petrol and transport diesel, therefore these fuels account for a large share in the amounts of total energy products consumed.

Sectors such as accommodation and catering services (I) with a value of 0,64, real estate operations (L) with 0,66 and health and social care sector (O) with 0,58 showed similar environmental sub-index values. A similar environmental dimension structure was observed for all three sectors. The sectors showed equally high values in terms of the following indicators: the greenhouse gas intensity and the share of the use of fossil energy sources, which indicate that the amount of their produced GHG emissions per added value and the share of fossil energy sources from total energy products is relatively low. All three sectors also showed approximately the same level of CO_2 productivity.

The health and social care sector (Q) with a value of 0,58, other services sector (S) with a value of 0,52 and wholesale and retail trade; automotive and motorcycle repair services sector (G) with a value of 0,40 showed average environmental dimension sub-index values. These three sectors showed low values at the CO_2 productivity indicator compared to the other indicators included in the dimension. Wholesale and retail sector, the automobile and motorcycle repair services sector (G) reached relatively low value at the fossil energy indicator, which indicates that the sector depends on a high proportion of fossil energy use relative to the total energy products consumed. According to the CSB data, the sector consumes high volumes of diesel fuel which in turn contribute to large share of fossil energy used in the sector. Annex 3 summarizes the values of the environmental dimension indicators for each of the service sectors.

2.2.4. Energy efficiency composite index

Total results of the energy efficiency composite index illustrate the energy efficiency structure of each sector. The obtained final EEI grade makes it possible to observe how all three dimensions that are incorporated in the EEI affect each sector's energy efficiency results. There could be observed significant differences between the sectors that are determined by each dimension's contribution to the overall service energy efficiency composite index.

The results of the energy efficiency composite index (see Figure 2-6.) ranges from 0,26 to 0,88. The average index value between the sectors equals 0,49. In total, 6 sectors achieved scores above the average grade, representing exactly half of the sub-sectors included in the scope of the services energy efficiency composite index. These sectors are information and communication services sector (J) with a value of 0,88, education sector (P) with 0,59, professional, scientific and technical services sector (M) with 0,55, activities of administrative and service services sector (N) with 0,54, accommodation and catering services sector (I) with 0,52, public administration and defense; compulsory social security sector (O) with a grade of 0,50.

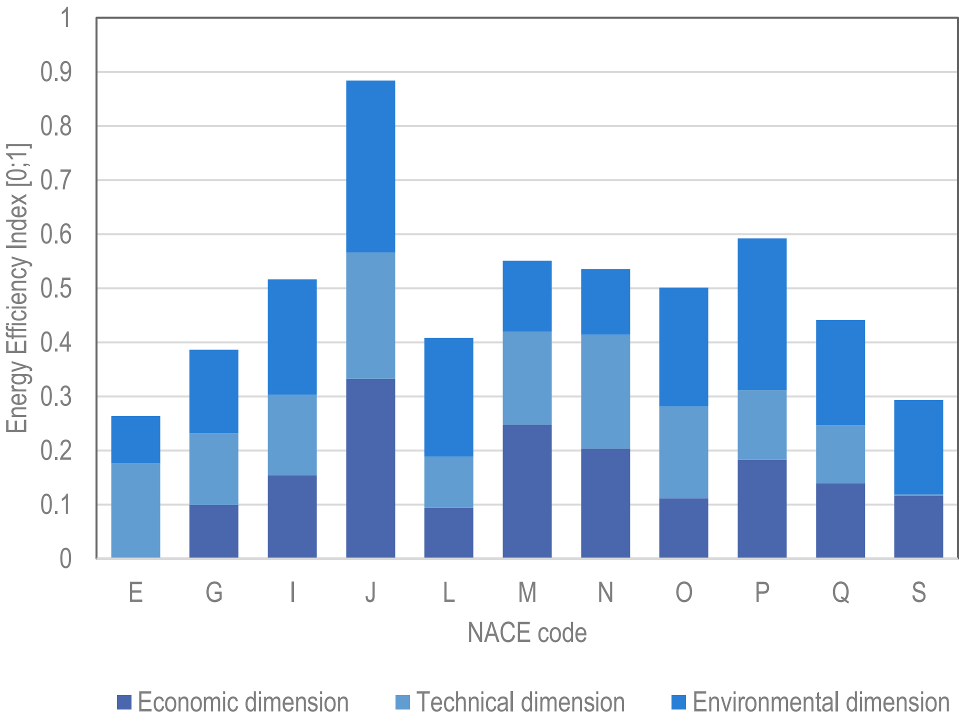


Fig. 2-6. Service sector energy efficiency composite index.

The highest value was reported by the information and communication services sector (J). The sector is a consistent leader in each of the dimension sub-index values incorporated in the EEI. As a result, the sector with a value of 0,88 also ranks in the leader position in the energy efficiency composite index.

The sector achieved almost the maximum possible value of 1 in two dimensions of the EEI obtaining a grade of 0,99 in the economic dimension and 0,96 in the environmental dimension. In the technical dimension, the sector reached a lower value, i.e. 0,7, however despite that the value was the highest among all the sectors in the technical dimension. Consequently, it can be concluded that the economic and environmental dimension indicators contribute the most for the information and communication services sector's (J) great performance in the total energy efficiency composite index. The relatively lower values in the technical dimension was influenced by a low number of companies implementing the ISO 14001 standard relative to the total number of economically active enterprises in the sector. The value of this indicator showed low results in the sector's technical dimension sub-index results.

Table 2-2. summarizes the values of economic, technical and environmental dimension sub-indices and the total results of the energy efficiency composite index (EEI).

Table 2-2.

The results for the economic, technical, and environmental dimension sub-indices and total service sector energy efficiency composite index (EEI)

	Dimension sub-index values			
NACE code	Economic	Technical	Environment	EEI
E: Water supply; waste water, waste management and recovery	0,00	0,18	0,09	0,26
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	0,10	0,13	0,15	0,39
I: accommodation and catering services	0,15	0,15	0,21	0,52
J: Information and communication services	0,33	0,23	0,32	0,88
L: Real estate operations	0,09	0,09	0,22	0,41
M: Professional, scientific and technical services	0,25	0,17	0,13	0,55
N: Activities of administrative and service services	0,20	0,21	0,12	0,54
O: Public administration and defence; compulsory social security	0,11	0,17	0,22	0,50
P: Education	0,18	0,13	0,28	0,59
Q: Health and Social Care	0,14	0,11	0,19	0,44
S: Other services	0,12	0,00	0,17	0,29

In almost all the public services sub-sectors, the energy efficiency composite index values reached above the figures average, with the exception of health and social care sector (Q). Public administration and defense; compulsory social security sector (O) achieved a value of 0,50, education sector (P) a grade of 0,59 and health and social care sector (Q) a value of 0,44. The average composite energy efficiency index value for public services sub-sectors reached a value of 0,51. In the public administration and defense; compulsory social security sector (O) between the three dimensions, the highest value was achieved by the environmental dimension (0,22). However, compared to the other two public sectors (P and Q sectors), the public administration sector reached a higher value in the technical dimension with a value of 0,17, where the education sector (P) achieved a value of 0,13 and the healthcare sector (Q) a valued of 0,11. In the education sector (P), significantly higher values were observed in the economic dimension (0,18) and in the environmental dimension (0,28), which among the public services sub-sectors were the highest values in the relevant dimensions. As a result, it ranked the sector in highest positions among other public services sectors. This indicates that the education sector (P) among the three public services sub-sectors analysed represent higher sustainable energy efficiency values. The lowest results among public services sub-sectors were observed in the health and social care sector (Q). This could be explained by limited availabilities and barriers to improving energy efficiency in the sector due to its specific operational activity. As well as in the health and social care sector (Q), there is a greater dependency on the technology utilization compared to the education sector (P).

The lowest services sector energy efficiency composite index values were observed in the water supply, sewage, waste management and recovery sector (E), which achieved a value of 0,26 and other services sector (S) that reached a value of 0,29. When comparing both sectors, significant differences can be observed. In the water supply, wastewater, waste management and recovery sector (E) dominated the technical dimension, while in the other services sector (S) dominant is the environmental dimension. The water supply, wastewater, waste management and recovery sector (E) is the only one with a non-existent economic dimension, that was determined by the lowest values obtained in all the economic dimension indicators. To compare, the other services sector (S) showed an economic dimension value of 0,12, however, the sector had the lowest technical dimension value compared to other sectors.

Sectors such as wholesale and retail trade; car and motorcycle repair (G) with a value of 0,39 and real estate sector (L) with a value of 0,41 in total represented the EEI values below the average, which indicates that sectors have lower energy efficiency among other services sectors included in the study. Given that both sectors are the largest energy consumers in the services sector (with a total consumption of 3,702 GWh of energy resources in 2017 or 41,2% of total energy consumption in the overall service sector (CSP, n.d.-b)), the low values of their EEI have a significant impact on the overall energy performance of the services sector. A common characteristic for these two sectors that can be concluded from the total EEI results, is their weak performance in the economic dimension sub-index. Despite the sectors' high output and value-added volumes, measured in absolute terms, their total monetary value and economic contribution is low relative to the amount of energy consumed. Consequently, the generated economic value cannot compensate the consumed energy resources at a competitive level.

By analysing the sectorial differences in more detail, the following trend could be observed. All the sectors that obtained energy efficiency composite index values above the average showed high indicator values for indicators with a negative impact on energy efficiency.

According to the composite index methodology, all indicators were grouped into two groups: with positive and negative impacts on the total energy efficiency index value (see section 2.1.3). Accordingly, indicators with a negative impact on the energy efficiency composite index were identified as taxes on energy (% of output), energy consumption per employee, greenhouse gas intensity, fossil energy use (% of total energy products). This means that the increasing values of these indicators have a negative impact on the energy efficiency in the sector. The composite index methodology includes this factor in the data normalization step and normalize the data according to an appropriate method so that the high values obtained in these indicators reflect the directly reversed relationship. Meaning that the higher the value in the negative impact indicator, the lower normalized indicator value it has obtained accordingly. For example, if a sector reached a high value in the greenhouse gas intensity indicator, which is reflected in the environmental dimension sub-index, the sector represents a low greenhouse gas intensity and is more environmentally friendly than the other sectors, respectively.

As a result, the above-mentioned relationship that sectors with high values in negative impact indicators also showed higher values in the overall energy efficiency composite index was observed in the indicators such as energy taxation (% of output) – in the economic dimension, energy consumption per employee – in the technical dimension and greenhouse gas intensity – in the environmental dimension. Therefore, in sectors such as information and communication services (J), education sector (P), professional, scientific and technical services sector (M), administrative and service activities sector (N), accommodation and catering services sector (I), public administration and defense; compulsory social security sector (O) the total cost of energy consumption relative to output volume is considerably lower (measured by the indicator – taxes per unit of generated output). These sectors consume less energy per total number of employees in the sector, as well as a lower amount of greenhouse gases per generated added value. It can be concluded that the total value of the EEI is significantly influenced by the negative impact indicators. Therefore, if the sector shows poor performance in the above-mentioned indicators, it is much more likely that it will show a low overall value of the composite energy efficiency index.

In addition, it was observed that the key indicator in the economic dimension, which also contributes significantly to the value of the total composite energy efficiency index, is the sector's ability to generate high added value per unit of energy consumed. The three sectors with the highest overall value of the energy efficiency index also showed the highest values in the indicator value - added value per unit of consumed energy.

None of the sectors reached the highest possible value of 1, indicating that significant improvements in energy efficiency are possible in each of the sectors examined, depending on their reported indicator values in the corresponding dimensions.

3. CHARECTARISTICS OF THE SERVICES SECTOR BY USING THE TOP-DOWN APPROACH

In order to carry out an assessment of the dynamics of economic performance and energy consumption tendencies in the services sector, a top-down data acquisition approach was used. According to a top-down approach methodology, an in-depth analysis of industry statistical data is carried out on the basis of publicly available databases. To describe sector's economic activity characteristics and its impact on the overall Latvian economy, the data from the Central Statistical Bureau (CSB) were collected and investigated.

Table 3-1.

Name of the subsection and corresponding data sources used

No.	Subsection name	Data source
1.	Analysis of the economic performance of the services sector	• CSB table IKG10_050 "Output of goods and services, intermediate consumption and gross value added by kind of activity (NACE Rev.2) (thsd euro)"(CSP, n.d.-c) • CSB table ATG015 "Exports and imports by commodity section and by economic activity (NACE Rev.2) of the importer (thsd euro)" (CSP, n.d.-a) • CSB table JVSG010 "Occupied posts by kind of economic activity on average per year"(CSP, n.d.-e) • CSB table SRG20 "Economically active enterprises by main kind of activity (NACE Rev. 2"(CSP, n.d.-i) • CSB table SBG020 "Key entrepreneurship indicators of enterprises by number of employees"(CSP, n.d.-h)
2..	Analysis of energy consumption data in the service sector	• CSB table ENG200 "Physical energy flow accounts (TJ)"(CSP, n.d.-b)
3.	Assessment of the competitiveness of energy efficiency in the service sector	• CSB table IKG10_050 "Output of goods and services, intermediate consumption and gross value added by kind of activity (NACE Rev.2) (thsd euro)" (CSP, n.d.-c) • ODYSSEE-MURE database, table "Total energy unit consumption in the service sector" (ODYSSEE-MURE, n.d.-b) • ODYSSEE-MURE database, table "Energy intensity in the service sector" (ODYSSEE-MURE, n.d.-a) • ODYSSEE-MURE database, table "Average energy consumption per business in the service sector" (ODYSSEE-MURE, n.d.-c)

Moreover, in order to assess the competitiveness of the service sector in the context of European Union, data from Odysee-Mure was obtained and analysed in detail. Odyssee-Mure is a multi-year project financed by the Horizon 2020 program of the European Commission. It includes a development of a comprehensive and valid statistical database on the key energy efficiency indicators for four major sectors in the EU Member States, including industry, transport, household, and services sector (ODYSSEE-MURE, 2019). Database provides valuable insights on the national energy efficiency performance across sectors and allows to make cross-comparisons among EU countries to identify potential cornerstones and opportunities for energy efficiency improvements. The total description of the chapter includes the three essential sub-chapters, which are summarised in Table 3-1. In addition, the table lists the data sources used in each of the subsections.

In the descriptive part of the first two chapter subdivisions, an analysis of economic indicators and energy consumption ratios is carried out. The analysis includes the following sub-sectors of the service sector, which are classified according to NACE Rev. 2 classification (CSP, n.d.-f):

- E – Water supply; sewage, waste management and remediation activities;
- G – Wholesale and retail trade; repair of motor vehicles and motorcycles;
- I – Accommodation and food service activities;
- J – Information and communication;
- K – Financial and insurance activities;
- L – Real estate activities;
- M – Professional, scientific and technical services;
- N – Administrative and support service services;
- O – Public administration and defense; compulsory social security;
- P – Education;
- Q – Human health and social work activities;
- R – Arts, entertainment and recreation;
- S – Other services;
- U – Activities of extraterritorial organizations and bodies.

3.1. Analysis of economic indicators

As part of this section, data on various economic indicators of the services sector are compiled, including indicators such as the output of goods and services in the sector, the generated added value, export volumes, the number of people employed in the sector and the number of enterprises operating in the sector. In the composite index study that was described and outlined in the previous section, it was concluded that the economic viability of a sector significantly determines its energy efficiency performance. Therefore, this sub-chapter focuses on investigating the service sector's economic characteristics.

The economic activity of the service sector is very important, and the sector contributes significantly to the overall Latvian economy. The overall service sector's generated value added, and gross domestic product contribution is significantly higher compared to other sectors in the economy. In 2019, all service sub-sectors accounted for a total of 66,1% (EUR 17,5 billion) from total value added and 50% (EUR 28,2 billion) of gross domestic product (GDP).

Figure 3-1 illustrates the value added of the service sub-sectors and the share of the GDP contribution to the economy over a 10-year period. It can be seen that the overall share of value added in the economy in the last 10 years has increased from 62,7% in 2010 to 66,1% in 2019. Consequently, the economic activity of the sector in the country is of increasing importance.

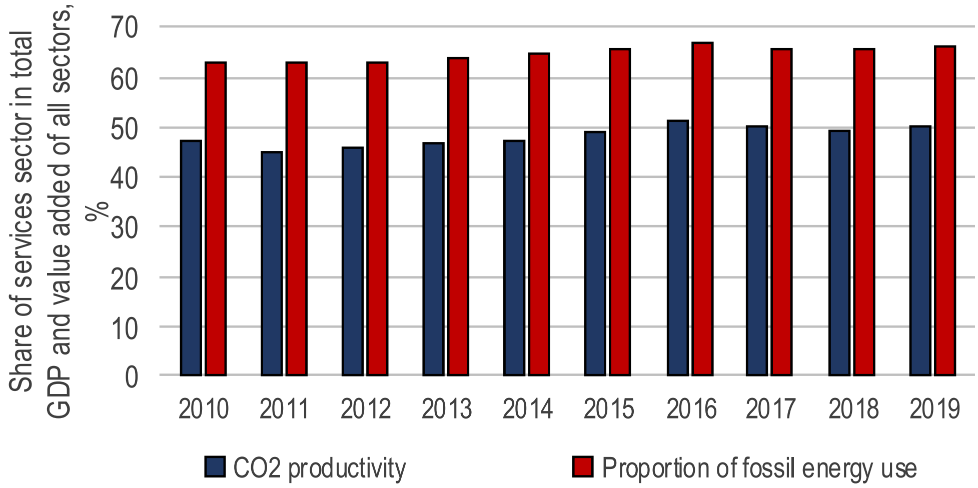


Fig. 3-1. Share of the 10-year contribution of the services sub-sectors to the economy (CSP, n.d.-c).

Given the fact that there were missing data on generated value added and GDP for the years 2018 and 2019 in the other services sub-sector (S), then for the years concerned, the figures for 2017, which were the most recent available statistical data in the CSB database, were included for a particular sub-sector.

When assessing the sector's value-added and output data, it can be concluded that following the financial crisis in 2009, the economic growth of the sector is experiencing an upward trend and an increase in values is observed on an annual basis. After the crisis in 2008, the value-added and GDP indicators of the services sector declined sharply. In 2010 GDP decreased from EUR 23,2 billion (in 2008) to EUR 17,6 billion and added value from EUR 14 billion (in 2008) to 10 billion EUR. Starting with the year 2011, the growing trend in the respective ratios was observed, representing an annual increase of around EUR 1 billion. In 2019, GDP increased to 27 billion EUR and value added increased to 16,7 billion EUR.

Figure 3-2 outlines the GDP and value-added values of all service sub-sectors. The majority of GDP and value added generated by the services sector is composed of a group of the following sub-sectors according to the NACE classification: professional, scientific and technical activities; administrative and support activities (M-N), information and communication services sector (J); financial and insurance activities sector (K). Together they represent an average of 6,5 billion EUR of GDP and 3,5 billion EUR value-added per year. The figures for wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) represent an average of EUR 5,2 billion and EUR 2,9 billion per year, respectively. The public sector, which includes Public administration and defense; compulsory social security (O), the education sector (P) and human health and social work activities (Q) represent an average of 4,8 billion EUR 3,4 billion of GDP and EUR 3,4 billion added value. The real estate activities sector (L) also accounts for a large part in the economic contribution, since it has an average annual GDP of 3,6 billion and added value of 2,6 billion EUR. Other sectors including arts, entertainment and recreation sector (R), other services sector (S) and accommodation and food service activities sector (I) have average annual GDP and value-added ratios equal to EUR 1,9 billion and EUR 1 billion EUR respectively (CSB, n.d.-c).

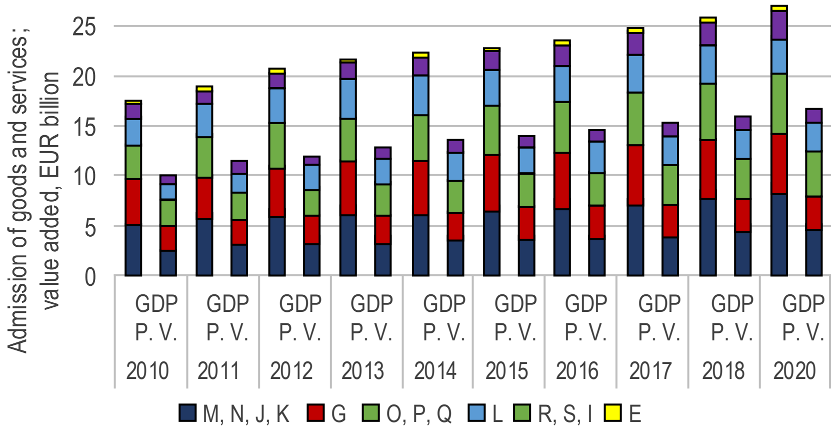


Fig. 3-2. Services sector GDP and value-added indicators over a 10 year period, broken down by service sub-sectors (CSB, n.d.-c).

In 2019, the services sector accounted for 45,5%, or EUR 5,82 billion, of the country's total export volume. A vast majority of the export amount was made up by the wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) which amounted to EUR 5,6 billion in the reported year. On average, the remaining services sub-sectors represent only EUR 258 million of export volumes per year. It can therefore be concluded that the export portfolio of the service sector is not diversified and highly dependent on only one sector, i.e. wholesale and retail trade; repair of motor vehicles and motorcycles sector (G). In total, it can be observed that there is an upward trend in the export volumes of the services sector. Since the year 2009 (with a value of EUR 2,3 billion) the value has almost tripled in a 11-year period (see Figure 3-3.).

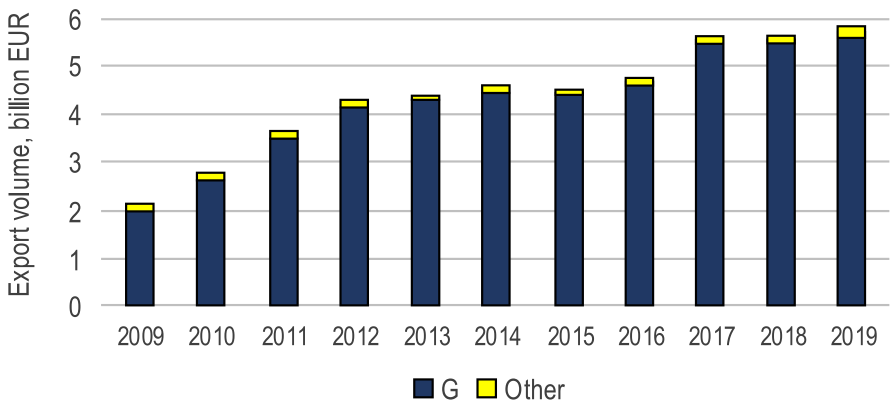


Fig. 3-3. Service Sector Exports Indicator for 11 years (CSB, n.d.-a).

The services sector provides not only a significant contribution to the country's overall value-added and GDP, but it is also one of the largest employers' in Latvia. On average, 624 thousand employees are employed in the service sector. In 2019, 68,2% of the country's total employment figures were occupied by the service sector. The breakdown of the number of persons employed by service sector can be seen in Figure 3-4. According to data from 2019, wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) employed 145,7 thousand people, or 15,9% of the total number of employees working in service sub-sectors. The public sector accounts for a significant proportion of the total number of persons employed in the country. In 2019, the education sector (P) employed 98,5 thousand people, or 10,8% of the total number of employees in the country. The human health and social work activities sector (Q) employed 70,1 thousand people, or 7,7% of the total number of employees and Public administration and defense; compulsory social security (O) employed 63,1 thousand people, or 6,9% of the country's total number of employees.

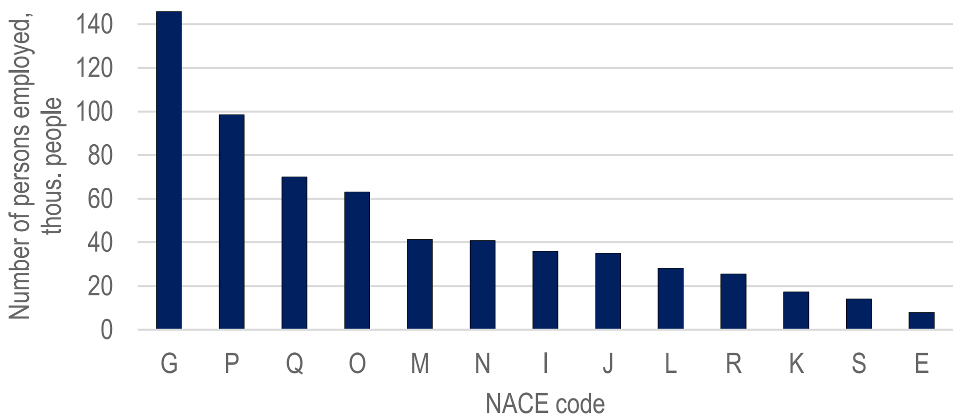


Fig. 3-4. Number of persons employed by each service sub-sector in 2019 (CSB, n.d.-e).

The number of economically active enterprises among Latvian service sub-sectors increased sharply between the year 2013 (106,5 thousand companies) and 2016 (131,6 thousand companies), but in recent years the total number of companies represented 126 thousand in 2018. The majority of the companies in the service sector is composed separately by the wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) – an average of 27,8 thousand companies. The remaining sectors represent a lower share of the number of economically active enterprises separately, so they were grouped together accordingly in order to obtain a comprehensive outlook of the situation. Figure 3-5. shows changes in the total number of economically active companies in the service sector.

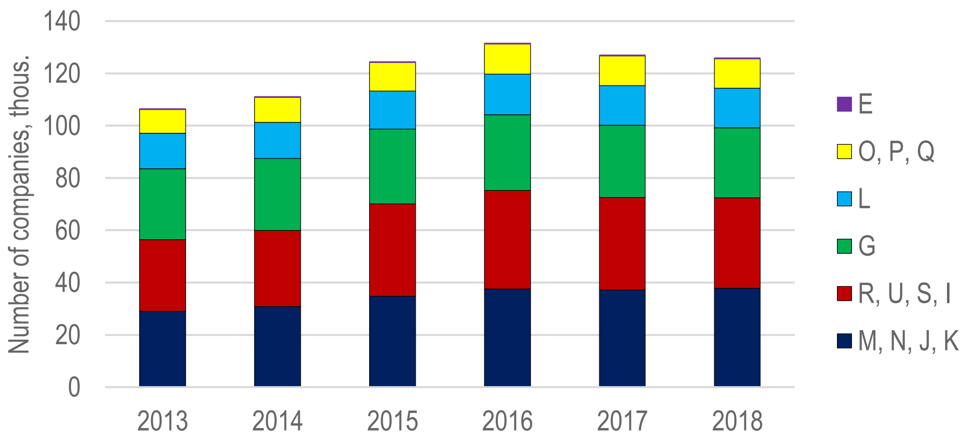


Fig. 3-5. Changes in the number of economically active enterprises in the service sub-sectors (CSB, n.d.-i).

According to the classification of economic enterprises introduced by the European Commission (EC), the companies are classified as follows (European Commission, 2003):

- Large companies: with more than 250 employees;
- Medium-sized companies: between 50 and 250 employees;
- Small companies: between 10 and 50 employees;
- Micro-enterprises: between 1 and 10 employees.

Since there is no available data for all service sub-sectors in the breakdown by number of employees, the analysis was carried out for the largest service sub-sector: wholesale and retail trade; repair of motor vehicles and motorcycles sector (G). In 2017, a total of 27 667 economically active companies operated in the sector. Small and large companies (including medium-sized companies) represented 7% and 1% of the total number of companies in the sub-sector G in the given year (see Figure 3-6.).

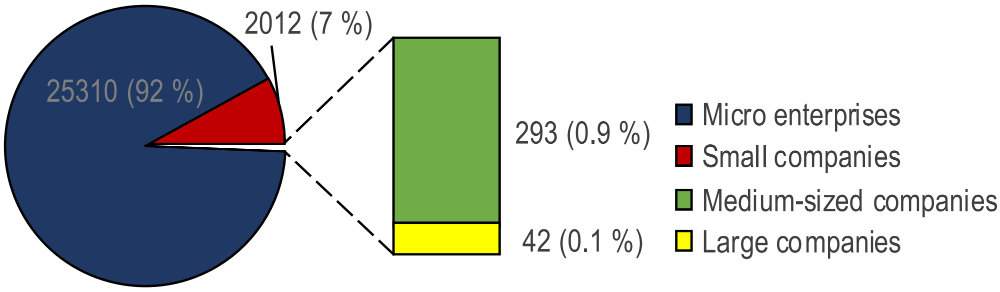


Fig. 3-6. Number of companies in a wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) according to EC classification.

The largest share in wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) is made up by the micro sized enterprises that accounts for 92% of the total number of companies in the sub-sector. However, despite the large number of micro sized enterprises, together they represented only 20% or EUR 0,5 billion of the total added value of the sector in 2017. Large enterprises with a share of just 0,1% (42 companies in 2017) represent 23% or EUR 0,6 billion of the added value in the sub-sector (see Figure 3-7.).

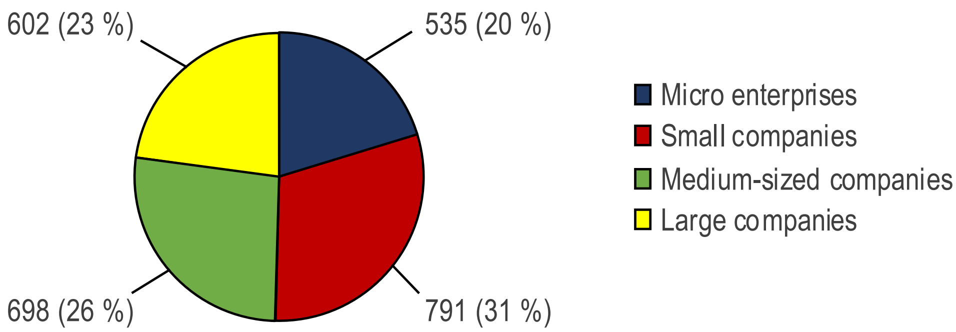


Fig. 3-7. Value added (billion EUR) in a wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) according to EC classification.

The most relevant indicators from the investigation of the economic performance ratios are summarized in the Table 3-2. The values for exports, value added, number of persons employed, number of economically active enterprises are expressed in percentages as a proportion from the total figure in the sector.

Table 3-2.

The proportion in the analysed economic ratios (export, value added, number of persons employed and number of economically active) of the service sub-sectors

	Export rate,% (2019) (CSP, n.d.-a)	Added value,% (2019) (CSP, n.d.-c)	Number of persons employed,% (2019) (CSP, n.d.-e)	Number of economically active enterprises,% (2018) (CSP, n.d.-i)
Service sector from total	45,5	66,1	68,2	68,2
E	0,3	0,9	0,9	0,2
G	43,8	14,0	15,9	14,5
I	0,2	2,0	3,9	2,2
J	0,3	5,8	3,8	4,0
K	0,1	3,2	1,9	1,2
L	0,3	12,4	3,1	8,2
M	0,2	5,0	4,5	11,0
N	0,2	3,3	4,5	4,2
O	0	7,8	6,9	0,3
P	0,0001	4,9	10,8	2,5
Q	0,01	4,0	7,7	3,3
R	0,03	2,1	2,8	4,1
S	0,01	0,8*	1,5	12,3
U	0	0	0	0,001

* 2017-year data

3.2. Energy consumption data analysis

Analysis of energy consumption data in the services sector is carried out below. It uses the data from Central Statistical Bureau's (CSB) the energy flow accounts (ENG200) for 2017, which was the most up-to-date data at the time of the study. For the services sector, this was the only available publicly available source of data on the volume of energy consumption in an accurate distribution of the sub-sectors, which also justifies the choice of the data included in the analysis.

In 2017, the previously listed service sub-sectors accounted for a total of 11,6%, or 8 997 GWh, of the total energy consumption of all sectors in the economy (including all NACE classes A – U). The largest share of energy consumption in the services sector consists of an energy consumption by the wholesale and retail trade; repair of motor vehicles and motorcycles (G) with 2,5% (2 471 GWh), real estate sector (L) with 24,5% (2 206 GWh) and Public administration and defense; compulsory social security sector (O) with 16,8% (1 510 GWh).

The lowest consumption was observed in the activities of extraterritorial organizations and bodies sector (U), which consumed only 5 GWh in 2017, that is approximately equal to 0,1%. A more detailed distribution of energy consumption by service sub-sector is reflected in Figure 3-8.

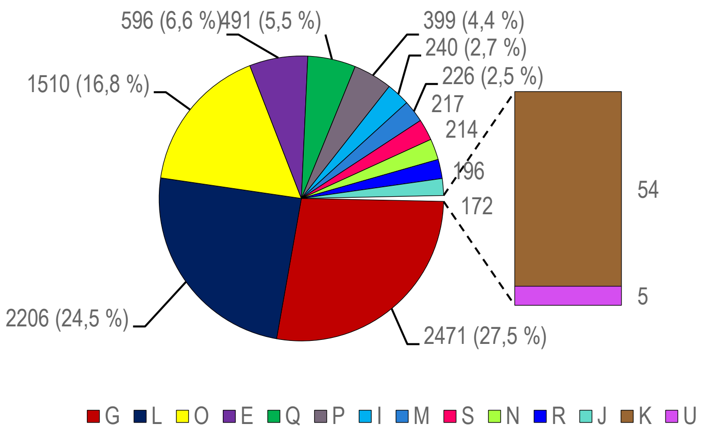


Fig. 3-8. Breakdown of total energy consumption by service sub-sectors in 2017, GWh (CSB, n.d.-b).

In a 6-year cut (from 2012 to 2017), the change in total energy consumption among the service sub-sectors was minimal, but the overall trend is upward. The highest value of the energy consumption indicator was achieved in 2016, representing a total of 9 319 GWh. However, in the previous year, i.e. 2015, the figure was 8 620 GWh — the lowest value in a 6-year cut. In 2017, energy consumption in the service sector amounted to 8 997 GWh (see Figure 3-9.).

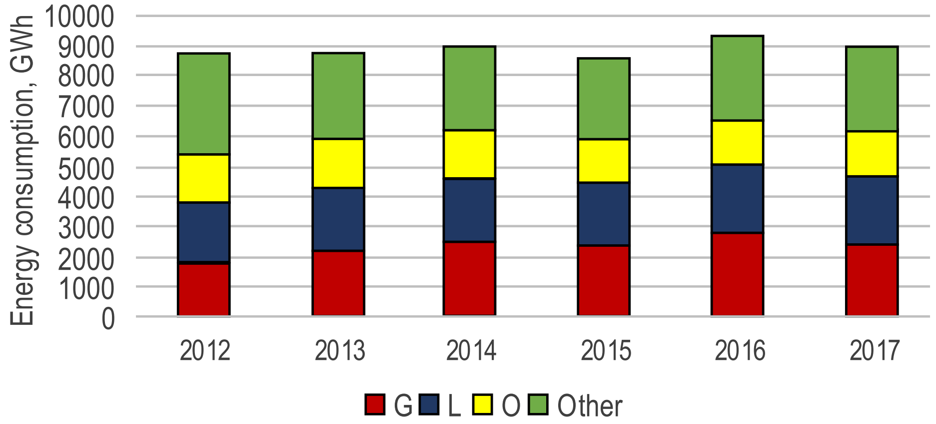


Fig. 3-9. Total energy consumption of the service sector over a 6 year period (CSB, n.d.-b).

The consumption of energy resources in the service sector by type of energy products used is reflected in Figure 3-10. It can be observed that electricity, heat and transport diesel are the main products used in the service sector. Electricity consumption accounts for 26% (2 354 GWh) of the total energy consumption in the service sector. 17% and 16% of total energy consumption is represented by heating and diesel, respectively. Total consumption of wood, natural gas and renewable biomass accounts for 13% of total energy consumption. The consumption of other energy sources (coal (including coke, lignite, etc.), petrol, kerosene, heating gas oil, fuel oil, biogas, liquid biofuels and other petroleum products) together accounts for a lower proportion or 7% of the total energy consumption of the services sector (see Figure 3-10.).

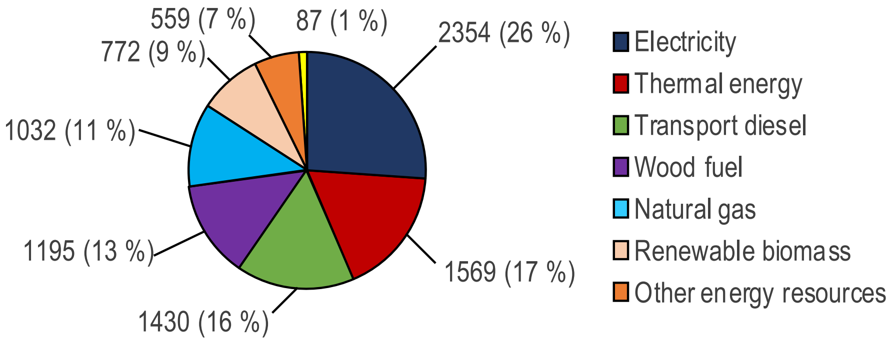


Fig. 3-10. Breakdown of consumption of different energy sources in 2017 by service sub-sectors, GWh (CSB, n.d.-b).

Given that three sectors of the services sector – wholesale and retail trade; repair of motor vehicles and motorcycles (G), real estate sector (L) and Public administration and defense; compulsory social security sector (O) together account for 68,8% of the total energy consumption in the sector, these sectors are further examined separately in more detail. In order to investigate their energy consumption trends and specific sector characteristics. In addition, an analysis of the total energy consumption in the public administration and defense; compulsory social security sector (O), human health and social work activities sector (Q) and education sector (P) is analysed separately.

Energy consumption data analysis for the wholesale and retail trade; repair of motor vehicles and motorcycles sector (G)

Wholesale and retail trade; repair of motor vehicles and motorcycles (G) includes NACE codes No 45 (wholesale, retail and repair of motor vehicles and motorcycles), 46 (wholesale, excluding motor vehicles and motorcycles) and 47 (retail trade excluding motor vehicles and motorcycles) (CSB, n.d.-f). Total wholesale and retail trade; the automotive and motorcycle repair sector (G) accounts for 2,5% or 2 471 GWh of the total energy consumption in the service sector. This value consists mainly on the use of transport diesel (31%), renewable biomass (24%) and electricity (19%). The least used are liquid biofuels (4 GWh). The consumption of other energy sources in the sub-sector G can be seen in Figure 3-11.

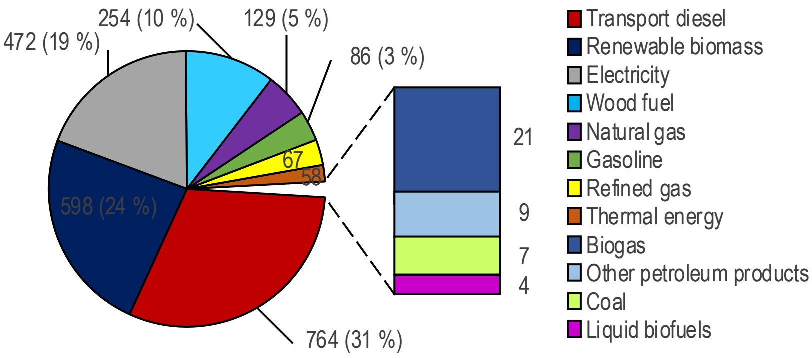


Fig. 3-11. Wholesale and retail sector (G) consumption of different energy sources in 2017, GWh (CSB, n.d.-b).

When assessing the energy consumption trend over the period from 2012 to 2017, it can be observed that the maximum energy consumption amount in the wholesale and retail trade; repair of motor vehicles and motorcycles sector (G) was reached in 2016 - 2 849 GWh but at a minimum in 2012 and was equal to 1 847 GWh. In general, an upward trend in the energy consumption can be observed in the 6-year period, however, in general, the fluctuations are identified (see Figure 3-12.).

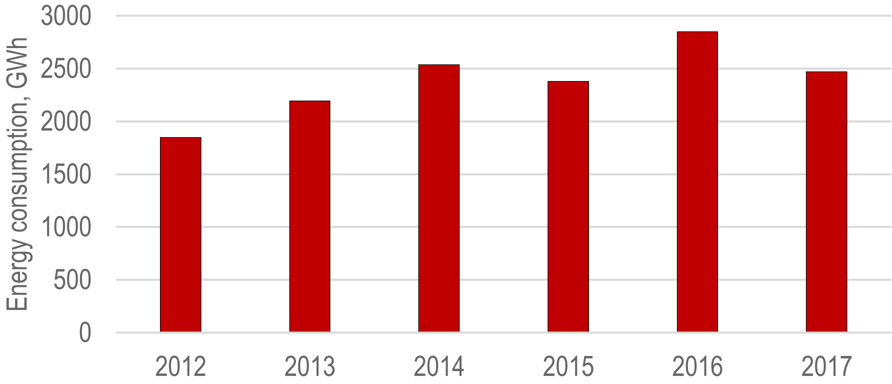


Fig. 3-12. Total energy consumption over a 6 year period in the wholesale and retail sector (G) (CSP, n.d.-b).

Energy consumption data analysis for real estate sector (L)

Real estate sector (L) corresponds to NACE classification code No. 68 (CSP, n.d.-f). The sub-sector accounts for 24,5% or 2 206 GWh of the total energy consumption in the service sector. This value is mainly composed of electricity (42%), thermal energy (26%) and natural gas (21%). Heating gas oil (0,3 GWh) is least used in the mentioned sub-sector. More detailed representation of consumed energy products in the sub-sector can be seen in Figure 3-13.

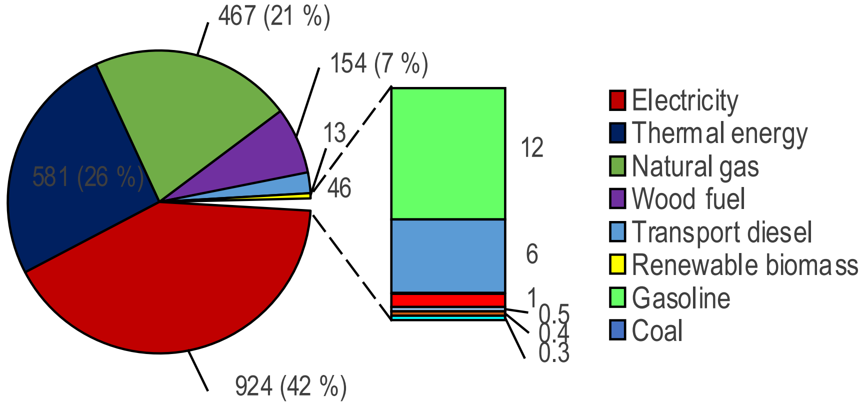


Fig. 3-13. Distribution of consumed energy products in 2017 in the real estate sector (L), GWh (CSP, n.d.-b).

The maximum energy consumption in the real estate sector (L) that amounted to 2 206 GWh, was reached in 2017. The minimum value was reported in 2012, representing 1 893 GWh. The trend in total consumption is steadily increasing; annual fluctuations do not exceed 300 GWh (see Figure 3-14.).

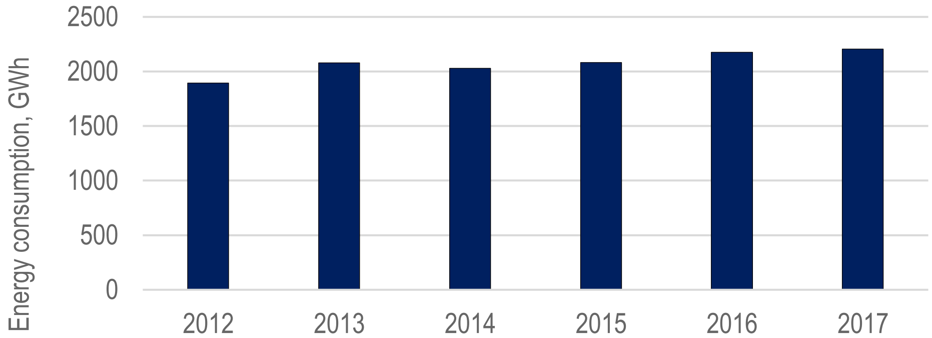


Fig. 3-14. Total energy consumption in the real estate sector (L) over a 6 year period from 2012 to 2017 (CSB, n.d.-b).

Energy consumption data analysis for public administration and defense; compulsory social security (O) sector

Public administration and defense; compulsory social security sector (O) corresponding to NACE classification code No 84 (CSP, n.d.-f) accounts for 16,8% or 1 510 GWh of the total energy consumption in the service sector. This value is mainly composed of electricity (42%), thermal energy (26%) and natural gas (21%). Heating gas oil (0,3 GWh) is the least used in the mentioned sub-sector. More detailed representation of consumed energy products in the sub-sector can be seen in Figure 3-15.

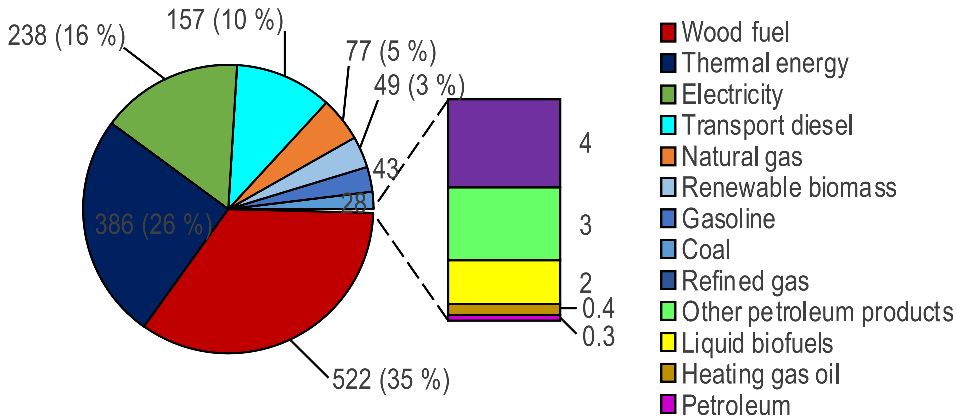


Fig. 3-15. Distribution of consumed energy products in 2017 in public administration and defense; compulsory social security sector (O), GWh (CSB, n.d.-b).

Energy consumption in the public administration and defense; compulsory social security sector (O) decreased from 1 681 GWh in 2012 to 1 615 GWh in 2014. In 2015, a sharp drop (reaching 1 412 GWh) in energy consumption was observed, but starting with the year 2016 an upward trend is observed (see Figure 3-16.).

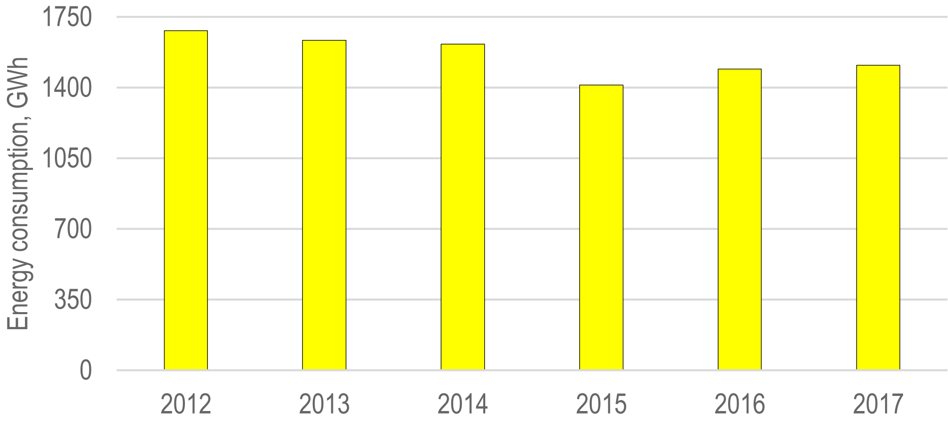


Fig. 3-16. Total energy consumption in the public administration and defense; compulsory social security sector (O) over a 6 year period from 2012 to 2017 (CSB, n.d.-b).

When comparing the three largest energy consumers in the service sector (G, L and O), differences in the amount of energy resources consumed can be observed. The wholesale and retail sector (G) uses largest share of transport diesel fuel. This is justified by the specific nature of the sub-sector which includes transport, sales and supply of the products. It is likely that the large amounts fuel is consumed by the international trade services which includes the transportation over the borders, as a result consuming more resources than it would be necessary in the case of local transit. The operation of real estate sector (L) is based on the provision of electronic services, resulting in higher volumes of electricity consumption in this sub-sector. Heating is necessary to ensure the climate conditions in the offices, so the total consumption of heat and natural gas (gas boilers) amounts to a similar value as for electricity consumption. However, public administration and defense; compulsory social security sector (O) consumes more energy resources on heating than it is utilized in the above-mentioned sectors, and wood is used as the main component for the heating.

Energy consumption data analysis for the public sector (O, Q and P)

The public administration and defense; compulsory social security sector (O), human health and social work activities sector (Q) and education sector (P). These sectors corresponds to NACE classification codes No 84-88 (CSP, n.d.-f).

The public sector accounts for around a third of the total energy consumption in the services sector, which is equal to 2 547 GWh. On average, the public administration and defense; compulsory social security sector (O) accounts for 61% of energy consumption by the public sector (1 557 GWh). The sub-sectors health and social work activities sector (Q) and education sector (P) represent 20% (504 GWh) and 19% (486 GWh) of energy consumption respectively (see Figure 3-17.).

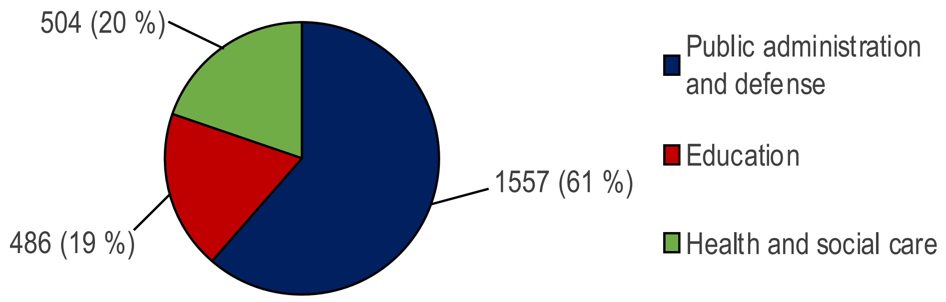


Fig. 3-17. Energy consumption in the public service sub-sectors in 2017, GWh (CSB, n.d.-b).

Total energy consumption in public sector decreased in a time period from 2012 to 2017. In 2012, the total energy consumption accounted for 2 838 GWh, most of which consisted of wood resources (994 GWh) and heat (761 GWh). Since 2012, total energy consumption decreased annually and reached the lowest level in 2015 (2 290 GWh). Moreover, the consumption of wood and thermal energy decreased to 668 GWh and 577 GWh in the corresponding year, respectively. However, the consumption of transport diesel (164 GWh in 2012; 220 GWh in 2015) and electricity (393 GWh in 2012; 411 GWh in 2015) increased. In 2016, total energy consumption increased to 2 484 GWh, however, it decreased again in 2017 and amounted to 2 399 GWh. Consumption of other energy resources (petrol, natural gas, renewable biomass, etc.) continued to decline annually during the period considered. The downward trend in total energy consumption is observed, according to data representation in Figure 3-18.

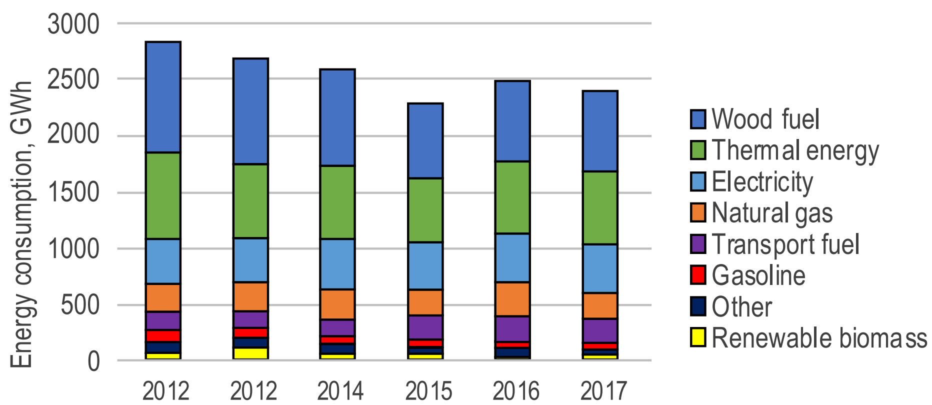


Fig. 3-18. Distribution of consumed energy products in the public sector over a period of 6 years from 2012 to 2019 (CSB, n.d.-b).

3.3. Assessment of the competitiveness of energy efficiency in the sector

In this part of the chapter, which includes an assessment of the specific energy consumption of the sector and a comparison of the energy consumption of the service sector in the context of the European Union.

3.3.1. Specific energy consumption

By expressing the specific energy consumption in the service sector (volume of energy resources consumed, GWh/added value, million. EUR) and by studying its dependence on the volume of generated added value, a declining trend is observed. The resulting regression equation is reflected in the graph (see Figure 3-19.). The resulting relationship reflects a trend that with a higher generated output and added value, energy consumption per unit of generated value-added decreases. Consequently, the sector benefits from large output volumes and then works more competitively, reducing overall energy costs. The correlation factor R^2 equals 0,7894, indicating that the relationship is strong ($R^2 > 0.7$).

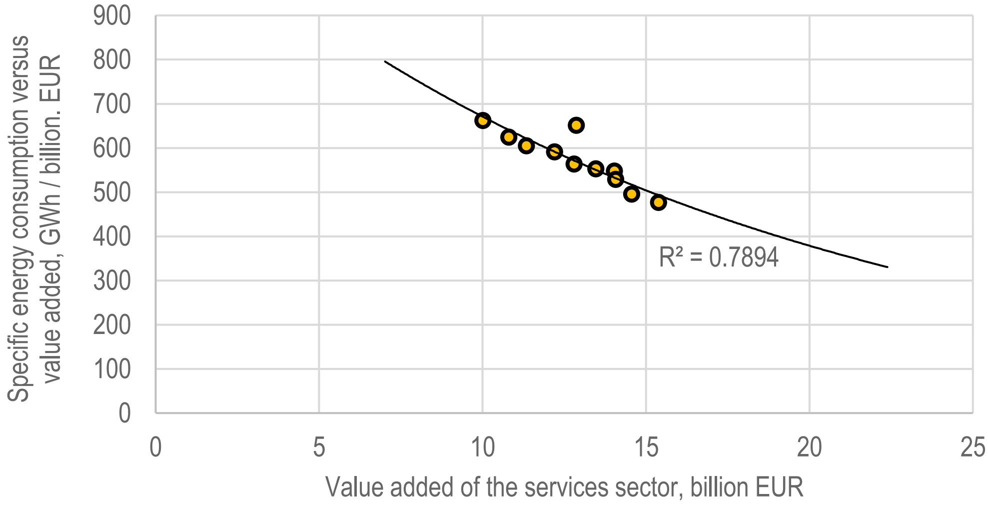


Fig. 3-19. Regression analysis of the specific energy consumption depending on valu-added (CSB, n.d.-c; ODYSSEE-MURE, n.d.-b).

3.3.2. Sector energy consumption in the context of the European Union

Since the beginning of the 21st century, the energy utilization intensity in the services sector in the European Union (EU) has changed with small variations (see Figure 3-20.). On the average of all EU Member States, this indicator amounts to 0,2 kWh/EUR per year. In the Baltic States, the indicator exceeds the EU average. In Latvia, the energy utilization rate has reached its historical peak in 2001, when it amounted to 0,45 kWh/EUR. In 2008 it decreased to 0,35 kWh/EUR and continued to fall to 0,31 kWh/EUR in 2017. The energy utilization intensity in Estonia historically has changed unevenly. Several peak points are observed in the data over the period of 18 years. In 2014, Estonia achieved a peak of 0,37 kWh/EUR over the specified period and a value of 0,3 kWh/Euro in the following year. In Lithuania, changes in energy utilization intensity are similar to changes in Latvia's indicator – a gradual decrease from 0,28 kWh/EUR in 2001 to 0,21 kWh/EUR in 2017 (ODYSSEE-MURE, n.d.-a)

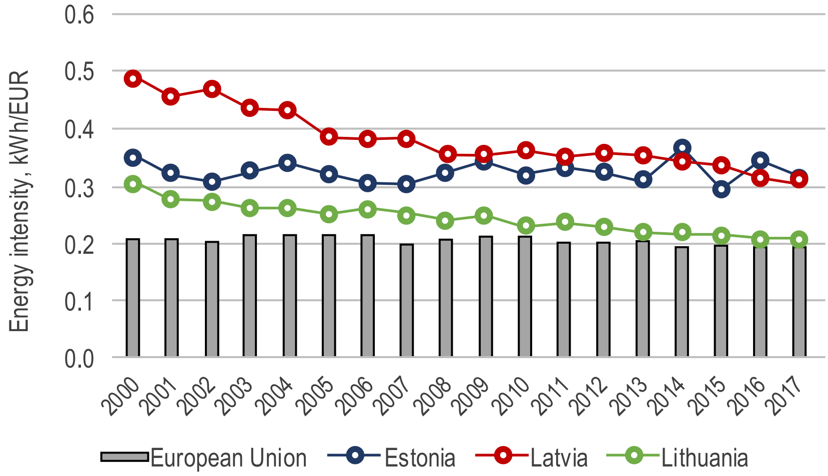


Fig. 3-20. Changes in energy utilization intensity of the services sector in the Baltic States and in the European Union (ODYSSEE-MURE, n.d.-a).

On average, among EU Member States, one company operating in the services sector consumed 10,7 MWh energy in 2017. The indicator is equal to an average energy consumption of a service company in Latvia in the specified year. Historically, the indicator changed with little fluctuation and declined in recent years. In Estonia, the consumption of a single service company increased significantly compared to the beginning of the century (2001 – 9,9 MWh; 2017 – 13,8 MWh) and exceeds the EU average. In Lithuania in 2017, on average, one service company consumed 8,5 MWh energy, which is significantly below the Latvian and the EU average values (see Figure 3-21.).

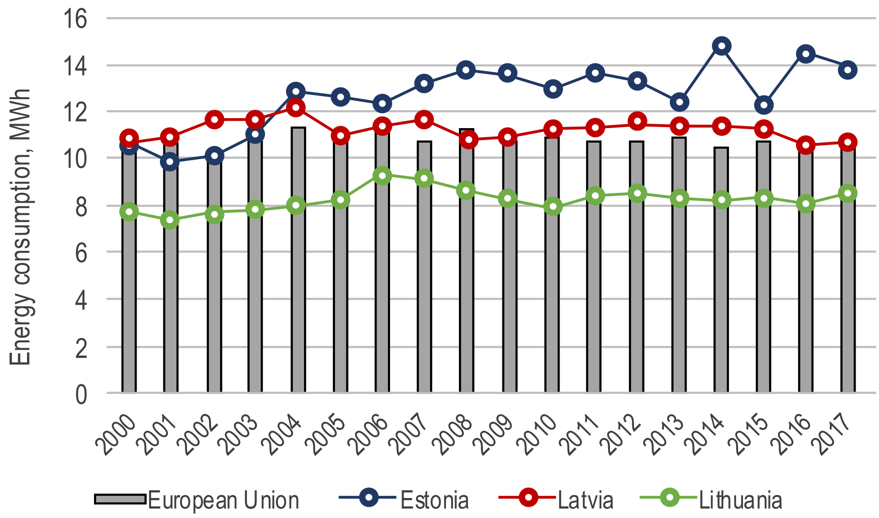


Fig. 3-21. Average consumption of one company in the services sector in the Baltic States and on average in the European Union, MWh (ODYSSEE-MURE, n.d.-c).

According to the Figures above, it can be concluded that although the average consumption of a service sector company in Latvia is within the values EU average, the energy intensity of the sector is significantly above the EU average. This means that the economic contribution generated by the service sector is lower and is currently unable to compete with the EU average.

CONCLUSIONS AND POLICY RECOMMENDATIONS

In this policy report an assessment of the energy efficiency potential of the service sector is performed by using a set of different methodological approaches, in order to obtain as detailed and objective as possible description on the sector's energy efficiency performance. The developed and utilized methodology is based on the three main research stages and their representative results.

Firstly, an in-depth analysis of the Energy Efficiency Monitoring System (EMS) data was carried out, as a result an economic energy efficiency potential was identified in the sector. It was calculated that the projected energy savings of EMS companies operating in the services sector amounted to 66,2 GWh, or 0,75% of the total energy consumption in the sector. The estimated potential for the savings of CO_2 emissions in the sector amounts for 5,7 thousand tons of CO_2, according to the projected reductions in energy consumption by the companies. In addition, calculations were made for theoretically possible technical energy efficiency potential, applying the Swedish benchmarks to each of the service sub-sector. The benchmarks were derived from Paramonova and Thollander scientific publication (Paramonova & Thollander, 2016). Together, it was found that the sector's total energy savings potential represents up to 22% of the total energy consumption in the sector, that is equal to 1 940 GWh of energy and 153 thousand tons of CO_2. It is concluded that the overall energy savings potential of the sector is significantly higher and it can be achieved in the long term with the availability of the best available technologies and in the absence of barriers related to the implementation of the energy efficiency activities. Policy makers need to put in place mechanisms to stimulate the implementation of energy efficiency activities in the companies operating in the sector, which would accelerate the expected reduction in energy consumption.

Secondly, an innovative energy efficiency assessment tool, the energy efficiency composite index, was developed, which included a comparison of the energy efficiency performance between the different service sub-sectors. The energy efficiency composite index included 9 different indicators grouped into three dimensions of energy efficiency: economic, technical and environmental. The calculated values of each dimension sub-indices and the energy efficiency index marked a number of significant differences between the sub-sectors. It was concluded that policy makers should take into account identified sectoral differences and the development of the sector specific regulations should be considered. It would allow to make the adjustments in the requirements for the implementation of energy efficiency activities for each sub-sector, and thereby making it possible to achieve higher energy savings in the sector as a whole.

Thirdly, through a top-down data acquisition approach, a detailed analysis of publicly available statistical data on key economic indicators and energy consumption trends in the service sector was carried out. The sector's overall energy consumption was identified to be relatively volatile in the recent years, but a declining trend has been observed in recent years. The three sectors with the largest energy consumption in total account for the largest share, or 69% of the total energy consumption in the sector. The sector's energy utilization intensity and consumption indicators were compared in the context of the Baltic States and European Union. It was concluded that the current energy utilization intensity of the sector is not competitive enough compared to the EU and neighbourhood countries. Therefore, the economic contribution generated by the sector does not compensate the energy amounts consumed at a sufficiently competitive level. As a result, it requires the development of a strategy to increase the long-term energy efficiency in the service sector.

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ANNEX

Annex 1: Economic dimension sub-index of the composite EEI

Dimension	Economic dimension			
NACE Code	**Value added per energy use**	**Output per energy use**	**Energy taxes per generated turnover**	**Total economic dimension sub-index**
E: Water supply; sewage, waste management and remediation activities	0,00	0,00	0,00	0,00
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	0,05	0,05	0,20	0,30
I: Accommodation and food service activities	0,08	0,10	0,28	0,46
J: Information and communication services	0,33	0,33	0,33	1,00
L: Real estate activities	0,05	0,03	0,20	0,28
M: Professional, scientific and technical activities	0,22	0,21	0,31	0,74
N: Administrative and support activities	0,15	0,16	0,30	0,61
O: Public administration and defense; compulsory social security	0,04	0,03	0,26	0,34
P: Education	0,13	0,09	0,33	0,55
Q: Human health and social work activities	0,07	0,05	0,30	0,42
S: Other services	0,03	0,03	0,28	0,35

Annex 2: Technical dimension sub-index of the energy EEI

Dimension	Technical dimension			
NACE Code	Investment per energy use	Share of ISO 14001 registered companies	Energy consumption per employee	Total technical dimension sub-index
E: Water supply; sewage, waste management and remediation activities	0,05	0,33	0,15	0,53
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	0,08	0,01	0,30	0,40
I: Accommodation and food service activities	0,12	0,00	0,33	0,45
J: Information and communication services	0,33	0,03	0,33	0,70
L: Real estate activities	0,16	0,01	0,11	0,28
M: Professional, scientific and technical activities	0,16	0,03	0,33	0,52
N: Administrative and support activities	0,25	0,05	0,33	0,63
O: Public administration and defense; compulsory social security	0,17	0,06	0,28	0,51
P: Education	0,05	0,00	0,33	0,39
Q: Human health and social work activities	0,00	0,00	0,32	0,32
S: Other services	0,00	0,01	0,00	0,01

Annex 3: Environmental dimension sub-index of the composite EEI

Dimension	Environmental Dimension			
NACE Code	Greenhouse gas intensity	Share of fossil energy resources	CO_2 productivity	Total environmental dimension sub-index
E: Water supply; sewage, waste management and remediation activities	0,00	0,26	0,00	0,26
G: Wholesale and retail trade; repair of motor vehicles and motorcycles	0,32	0,12	0,02	0,46
I: Accommodation and food service activities	0,33	0,24	0,08	0,64
J: Information and communication services	0,33	0,29	0,33	0,95
L: Real estate activities	0,33	0,29	0,04	0,66
M: Professional, scientific and technical activities	0,33	0,01	0,05	0,39
N: Administrative and support activities	0,33	0,00	0,04	0,37
O: Public administration and defense; compulsory social security	0,33	0,30	0,03	0,66
P: Education	0,33	0,33	0,18	0,84
Q: Human health and social work activities	0,33	0,22	0,03	0,58
S: Other services	0,33	0,16	0,04	0,52