Relevance of the EU Structural Funds’ Allocation to the Needs of Combating Air Pollution in Poland. Analysis of the Operational Programmes of Regions Threatened with Critical Air Pollution from Distributed Energy Sources

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Abstract. Recent years, the European Environmental Agency, has been reporting air quality parameters in Poland, as the poorest among all the EU countries. Despite of adoption of the EU legislation on energy efficiency and energy performance of buildings, existing legal solutions occur insufficient in reducing air pollution in Polish regions. Lack of an effective schemes supporting complex thermal renovation of buildings, exchange of inefficient boilers, developing district heating based on clean and renewable fuels results in severe health problems and 40 000 of premature deaths related to air pollution. Availability of the EU structural funds may become a tremendous opportunity, especially for the residential sector, to conduct a massive scale modernization. Nevertheless, lack of a coordinated action involving all levels of governance may put the opportunity at risk. The article aims to answer the question on the readiness of the regional governments to effectively implement energy efficiency measures mitigating the problem of air pollution. Second objective is to analyse whether the Regional Operational Programmes allocating the ERDF funds to support specific development needs of the regions, have been constructed in a way that properly addresses the problems related to energy performance of residential buildings.

1. Introduction

Annual reports by the European Environmental Agency [1] along with the World Health Organisation [2] provide a comprehensive information on the air quality in Europe, which indicate Polish cities and towns as the most exposed to air pollution among the European cities and towns. Statistics presenting the list of 50 EU urban areas where the PM2.5 annual concentrations has been exceeded [1] indicate 33 Polish cities. The list includes the cities located mostly in Silesian region (14 towns) and Małopolska (Lesser Poland) region (9 towns), Łódzkie region (5 towns) as well as 5 single towns from different regions.

Due to lack of the efficient financial medium or long-term financial instruments encouraging thermal renovation of single or multi-family houses, including change of the heat sources, the ERDF funds available for Poland within the Regional Operational Programmes [3-18], constitute an important instrument commencing the process of enhancing energy efficiency in the residential sector. The article aims to analyze the allocation of funds within Regional Operational Programmes for the period 2014-
2020, in terms of investment activities in energy efficiency, especially implemented in the formula of “umbrella projects”, in cooperation with private owners of residential buildings.

Structure of the article aims to reflect such aspects as current legal conditions in the area of energy efficiency, status of air quality in Polish regions, scale of allocations supporting energy efficiency in the Regional Operational Programmes as well as recommendations for effective implementation of the investment projects co-financed by European Regional Development Fund. First of the mentioned aspects – national legislation, besides adopting EU regulations in the area of energy efficiency, occurs insufficient to combat the problem of air pollution, without a systematic approach combining financial and legal instruments at the central, regional and local level of governance. The article summarizes current conditions in terms of air quality in Polish regions. Fundamental part of the article has analysed the allocation of ERDF funds for energy efficiency. Last part of the article summarizes conditions necessary for effective absorption of the ERDF funds and implementation of the projects.

2. Background

Directive 2008/50/EC of 21 May 2008 on ambient air quality and clean air for Europe (CAFE Directive) [19] specified threshold values for air pollutants, including sulphur dioxide, nitrogen dioxide and nitrogen oxides, particulate matter (PM10 and PM2.5), carbon monoxide and lead. Threshold value for the particulate matter, expressed as annual mean, imposes limits for PM10 at the level of 40 µg/m³ and for PM2.5 at 25 µg/m³ (stage 1, levels were supposed to be met by 1 January 2015) and 20 µg/m³ (stage 2, to be met by 1 January 2020). World Health Organization’s database on Ambient Air Pollution [2] contains records of particulate matter of 154 Polish cities and towns. Comparison of the PM10 concentrations indicates that 36 Polish cities exceed the annual mean value and over 100 cities and towns exceed the threshold values for PM2.5 (stage 2). The cities exceeding threshold values set for PM10 are located in Silesian, Lesser Poland, Łódzkie and Lower Silesian region. Threshold values for PM2.5 were exceeded in the cities located in the regions of Silesia (21), Lesser Poland (14), Lower Silesia (17), Łódzkie (12), Mazovia (10), Podkarpackie (7), Świętokrzyskie (5), Wielkopolskie (9), Kujawsko-Pomorskie (3), Opolskie (3), Pomorskie (2). The analysed data indicates the regions of Silesia, Lower Silesia, Lesser Poland and Łódzkie as the region where the problem of air pollution has reached a significant scale and measurements for both types of particulate matter are exceeding the annual mean values set by the CAFE Directive.

![Figure 1. Spatial distribution of PM10 concentrations in Poland (European Environmental Agency, 2017)](image-url)
The air pollution in Poland results in major extend from the low energy performance of buildings. The problem itself had received a significant attention in the European Union. Document of Europe 2020 Strategy [20] assumes the quantitative aims concerning reduction of CO₂ by 20% below 1990 levels, 20% increase in energy efficiency and 20% energy from renewable sources. Specific methods to achieve the assumed aims were formulated within the EU directives, including Directive 2012/27/EU on Energy Efficiency [21], Directive 2010/31/EU on energy performance of buildings [22] as well as the Directive 2009/28/EU on the promotion of renewable energy [23] and adopted to the legislation of the Member States.

Review of publications dedicated to energy performance of buildings in Poland is represented by an extensive analysis by Bukowski et al. [24], who claims that total energy costs incurred annually in private, public and entrepreneurial sectors amount to 70 billion PLN, in 2013 equal to 4% of Gross Domestic Product. The report noted that increase in energy performance of buildings may create significant savings for Polish economy resulting also in social benefits due to release of the finances allocated to energy. Analysis of energy performance of family single houses was conducted by (Dworakowska, 2016) [25]. According to the report single family houses in Poland amount to 3.5 million, that constitutes 70% of the total residential housing. Survey conducted by the authors on the representative group of the single house owners reveals that 70% of the houses are supplied with heat using coal boilers, out of which only 18.5% are the retort boilers and 80% are the hand-feeder boilers. Within this category of houses, the share slightly exceeding 40% has not possessed insulated external walls, while 49% of the houses possess the external walls’ insulation up to 10 cm.

The scale of the problem of low energy performance of residential houses has been underlined by the document of the “National Action Plan for the low-energy buildings” [26] that constitutes fulfilment of the obligations imposed by the Directive on the energy performance of buildings. According to the inventory concerning the age structure of the buildings, almost 72% of the existing buildings were constructed before 1988 and their primary energy consumption ranges from 160 to over 350 kWh/(m²·year).

In addition, lack of the effective national programmes supporting thermal renovation of private family houses is considered as a serious problem inhibiting increase of the energy performance of buildings. Analysis of the European programmes supporting energy performance of buildings, conducted by (Dworakowska, 2016) [25], present the scale of national support per capita, which in case
of Poland amounts to 0.16 EUR/capita. Highest capital expenditures are incurred in Slovakia, where the support amounts to 5.5 EUR/capita, while in Czech Republic the support amounts to 2.5 EUR/capita and Germany – 1.5 EUR/capita. The only functioning long-term programme, offering the thermal renovation bonus, within the Fund for Thermal Renovations and Retrofitting, established by the act on support of thermal renovation and retrofitting of November 21st, 2008, prove effective only in the case of large cooperatives and commons. Expenditures necessary to improve the energy performance of a building, presented by Bukowski et al. [24], amount to 45 EUR/m² in case of reduction of energy consumption from 215 down to 135 kWh/(m²·year). Further reduction of the energy consumption down to 60 kWh/(m²·year) amounts to 63 EUR/m². Both publications by Bukowski [24] as well as Dworakowska [25] emphasize the problem faced by most of the private owners of the single family houses, often originating from lower middle class, concerning accumulation of the necessary investment capital as one of the most significant problems inhibiting increase in energy performance of residential buildings.

Scale of the necessary investments improving the energy performance of buildings requires concerted action of public administration at all levels of governance and allocation of relevant funding at least for the medium-term perspective. Financial scheme supporting energy performance of buildings should involve funding available at all levels of administration and besides the central regulations (also adopting EU legislation), should be accompanied by local regulations, resulting from the involvement of spatial planning instruments assigned to local governments, which eventually create legally binding regulations. In the case of a concerted system supporting energy efficiency addressed especially to the private investors at local level, EU structural funds (ERDF) should constitute an important but rather supplementary element of the scheme. Supposedly, in the conditions lacking relevant national support scheme and lack of coordination of the action with the regional and local level, a risk can be expected that the ERDF funds are used in a non-efficient manner and thus – irrelevantly respond to the real problems of air pollution in the abovementioned regions.

3. Methodology

Major objective of the article is to analyze the allocation of funds available to polish regions from the European Regional Development Fund (ERDF), which aims to support infrastructural projects, including those related to energy efficiency and renewable energy. Allocation of the funds was determined by the Regional Operational Programmes [3-18], prepared by the Marshall Offices of the regions. The analysis aims to assess relevance of the funds’ allocation to the problems of air pollution, generated by insufficient energy performance of residential buildings along with ineffective heating systems, based on low-efficiency boilers fed with coal and wood. Besides assessment of the relevance of the funds’ allocation, the article aims at providing recommendations concerning the support schemes for energy performance of buildings at the level of the Member State as well as the role of spatial planning as a measure enforcing energy efficiency in the residential sector, specifically among the private owners of single-family or multi-family houses.

Methodology is based on the desk research conducted on the sixteen Regional Operational Programmes and analysis of the distribution of funds allocated for the investments in the field of energy efficiency and renewable energy sources. The review focused on the chapters dedicated to sustainable energy and involved analysis of the planned budgets and types of activities eligible for financing.

In order to facilitate presentation of the analyzed data, the cumulated data on budgets have been allocated to common categories. Due to the fact that parts of the programmes dedicated sustainable energy, includes activities and financial allocations into different types of activities, which are not consistent throughout the regions, presentation of the results require establishment of a set of common categories, in order to clearly present the budgets allocated to each type of activity in the area of energy efficiency and renewable energy sources.
Due to the differences in the description of activities, set of new categories contains separate categories, which duplicate activities contained in other categories, because of inability to separate budgets of two or multiple types of activities contained within one category. Example can be illustrated with a category called “low-emission strategies”, which in some programmes, contain activities for sustainable transport, exchange of inefficient boilers and thermal renovation of residential buildings. In most of the cases where few activities into one category had been included into one category, the allocated funds did not differentiate between the specific activities. Similar case could be observed in different Regional Operational Programmes [3-18], out of which part included “energy efficiency of public objects and residential buildings” as one activity (category), while other programmes separated activities aiming at improvement of energy efficiency at public buildings from residential buildings. Therefore, in order to gain a clear picture of supported categories of activities as well as the magnitude of allocated funds, duplication of the activities was necessary, to reflect full scope of the activities to be supported by the programmes. The scope of activities supported by the Regional Operational Programmes included: a) Energy efficiency of residential buildings, b) Energy efficiency of public buildings, c) Energy efficiency of public and residential buildings, d) Energy efficiency in enterprises, e) Sustainable transport and prevention of air pollution from distributed sources, f) Prevention of air pollution from distributed heat sources, g) Renewable energy sources, h) Cogeneration, i) Sustainable energy education. Regional Operational Programmes provide three types of financial instruments available for the potential beneficiaries. Support addressed to metropolitan areas has been included as a separate instrument, established by the Cohesion Policy 2014 – integrated territorial investments - promoting cooperation among municipalities and enhancing territorial and functional cohesion. Local communities behind the agreements on Integrated Territorial Investments, are eligible to apply for support in the form of grants offered within each of the activities defined by the programme. Besides the mentioned instruments, each of the activity areas offers support through financial instruments, namely loans or bank guarantees, available via dedicated regional funds. Analysis of the funds allocated for energy efficiency and renewable energy sources, does not differentiate the ERDF funds in terms of the support instruments offered within the programmes.

4. Results and discussion

Referring to the results of the WHO urban air pollution database [2], analysis of the funds allocated to activities on energy efficiency and renewable energy, has been conducted in major extend with regard to the regions facing most severe problems of air pollution. The problem of smog and excessive concentrations of particulate matter is relevant for the regions of Silesia, Lower Silesia, Lesser Poland and Łódzkie.

![Figure 3. Sustainable energy activities in the total budget of the Regional Operational Programmes](image-url)
Engagement of the regional authorities into combating the air pollution problem can be measured with the share of the funds allocated to sustainable energy activities in the total budgets of the Regional Operational Programmes, presented at Figure 3.

Total budget of the Regional Operational Programme is meant as the sum of contributions from the European Regional Development Fund and the European Social Fund. The highest intensity of the budgets allocated for the support of sustainable energy activities are the most intensive in the case of Silesian region with over 30% of the total budget of the Programme aims at supporting energy efficiency and renewable energy. Level of involvement of the Silesian region is the highest from among all the Polish regions and exceeds five times the involvement of the Lesser Poland (Małopolskie) region – as one of the regions with most air pollution. Involvement of the budget for energy efficiency and renewable, at the level of 6.25% from among all Polish regions. Involvement of other regions threatened with the highest air pollution, namely Lower Silesia (Dolnośląskie) and Łódzkie presents the levels of 16.75% and 9.97% respectively.

Data presented at Figure 4, reflects the intensity of support only for activities aiming at energy efficiency. Intensity of support addressed only to energy efficiency activities in analogical to the intensities of support addressed to both energy efficiency and renewable energy sources and reflects least budget at Lesser Poland region (małopolskie) and highest intensity in the case of Silesian region (Śląskie). Comparison of the intensity of the support intensity for energy efficiency and renewable energy sources, in each of the Regional Operational Programme, indicates significantly higher intensity of support for energy efficiency activities than to the implementation of renewable energy sources. That fact confirms high awareness of the regional authorities regarding necessity of improving energy performance of buildings, which constitute major reason for air pollution. However significant support for the renewable energy sources is visible in the Lesser Poland region (36% of the total support for sustainable energy activities).

Other regions which allocate higher budgets for the support of renewable energy sources include Lubelskie (36% of the allocation for sustainable energy activities), Podlaskie (33%), Warmińsko-Mazurskie (36.9%) and Zachodniopomorskie (30.84%). Intensity of support for renewable energy sources in other regions ranges from 6% of the total energy budget in Silesian region, while most of remaining regions planned the support at the level of around 20% of the total allocations for sustainable energy projects.
### Table 1. Categories of activities involving energy efficiency and renewable energy sources in the Regional Operational Programmes

| Category | Types of activities allocated to specific category |
|----------|--------------------------------------------------|
| a)       | Complex thermal renovation of multi-family housing  |
|          | Retrofitting internal heat installations of buildings |
|          | Exchange of distributed heat sources into energy-efficient |
| b)       | Complex thermal renovation of public buildings |
|          | Low-energy public buildings – demo projects |
|          | Energy efficient lighting |
|          | High-efficiency cogeneration and modernization of heat sources |
|          | Retrofitting internal heat installations of buildings |
|          | RES in thermally renovated buildings |
| c)       | Complex thermal renovation of public buildings |
|          | Complex thermal renovation of multi-family housing |
|          | Low-energy public buildings – demo projects |
|          | Energy efficient lighting |
|          | Micro-cogeneration for own purposes |
|          | Retrofitting internal heat installations of buildings |
|          | RES in thermally renovated buildings (generation for own purposes) |
| d)       | Deep thermal renovation, including exchange of energy source |
|          | Waste heat recovery |
|          | Energy efficient technologies and devices, incl. modernization of production lines into more efficient |
|          | Energy efficient lighting, Energy management systems |
| e)       | Purchase of low-carbon public transport fleet |
|          | Reduction of car traffic in city centres (park & ride, bike & ride, transfer hubs, charging stations for e-vehicles) |
|          | Energy efficient street and road lighting |
|          | Infrastructure prioritizing public transport, including traffic management systems |
|          | Projects indicated in the programmes for local low-carbon economies, incl. exchange of distributed heat sources, interconnection to heat distribution grids, installation of RES sources – gas or biomass boilers |
|          | Bicycle transport infrastructure, public bicycles rental system, |
| f)       | Construction or modernization of the distributed heat sources into energy-efficient and fed with natural gas or renewables |
|          | Energy efficient lighting, including street lighting |
|          | Air pollution monitoring and information systems |
|          | Development, construction and modernization of public buildings towards passive standards |
|          | Liquidation of individual heat sources in public and residential buildings, interconnection to the city or district heat distribution grid |
|          | Development or reconstruction of heat distribution grids including sources, pipelines, central heat exchangers and interconnections to buildings, Energy management systems |
| g)       | Generation and distribution of energy from renewable resources (wind, solar, biomass, biogas, hydro, geothermal) |
|          | Construction, modernization of power distribution grid, facilitating interconnection of renewable sources |
|          | Generation of renewable heat and/or electricity in micro installations |
|          | Construction of the bio components or 2nd and 3rd generation biofuels’ production plants |
|          | Construction of medium- and low-voltage distribution grids facilitating interconnection of renewable electricity sources |
| h)       | Construction of the high-efficiency combined heat and power sources |
| i)       | Retrofitting street lighting into energy efficient |
|          | Educational campaigns on energy efficiency |
|          | Educational campaigns on zero-emission buildings |
|          | Demonstration projects on passive buildings accompanied by educational activities |
The regions allocating more significant budgets, constituting over 30% of the total allocation for sustainable energy, are characterized by significant potential for the utilization of renewable sources for energy generation and, especially in the regions of Eastern Poland, by weak power grid infrastructure. As presented in Table 1, funds allocated to renewable energy support also development of the power grid infrastructure facilitating interconnection of the new renewable energy sources.

![Figure 5. Comparison of the intensity of support for energy efficiency and renewable energy projects within the Regional Operational Programmes](image)

The figures below present detailed division of the allocations supporting sustainable energy projects within the regions, indicating specific type of eligible project along with available funds. Explanation of the division into support categories and justification of the assignment of the specific types of projects to the common categories has been explained in chapter 3 dedicated to the methodology of the conducted research. Types of projects eligible for support, divided into categories, presented in Table 1, might be repeating in few categories, e.g. same type of projects are present in the category assigned with letters a), b), c), e) and f) that results from categorization of the projects in the regional programmes. Extraction of the specific types of projects and grouping into same category was often difficult due to lack of separate budgets for the specific activities. The example can be illustrated with activities assuming exchange of heat sources, which might be found in the most of the abovementioned categories. Therefore, presence of the categories addressing ‘energy efficiency of residential buildings (category “b”) or ‘Energy efficiency of public buildings energy efficiency in residential and public buildings’ (category “c”) and ‘Sustainable transport and prevention of air pollution from distributed sources’ (category “e”), in the allocation of specific region, means that funds for energy performance of buildings have been included in the category “a”, “b” or “c”, while category “e” offers funds for sustainable transportation. At the present moment, when the calls for projects in specific categories have not been closed it is not feasible to assess the extent of funds, which financed precisely selected type of activity, e.g. energy performance of public or residential buildings.

Analysis of the detailed division of the budgets allocated to sustainable energy activities provides a closer view of the potential projects to be financed by the Regional Operational Programmes, Figure 6, Figure 7. Allocation of ERDF funds in Silesian region (śląskie) as the most polluted among Polish regions, indicates budget of 200 million EUR for the activities improving energy efficiency of residential and public buildings and more than double budget for the projects supporting sustainable transportation. Significant budget exceeding 300 million EUR is allocated for the projects supporting energy efficiency measures in commercial sector.
Figure 6. Budget comparison through the regions
Figure 7. Budget comparison through the regions.
Division of the funds in the case of Lower Silesia region (dolnośląskie) indicates the budget exceeding 150 million EUR allocated to energy efficiency in residential and public buildings, while projects in the field of sustainable transportation can be supported with the budget exceeding 137 million EUR. Least amount of funds have been allocated to energy performance of residential and public buildings in the Lesser Poland region (małopolskie), amounting to 96 million EUR.

Analysis of the categories of projects eligible for support in the regional programmes also reveals only few regions possessing category of “Cogeneration” that assumes co-financing projects implementing high-efficiency combined heat and power technologies, which might potentially support modernization of district heating plants supplying heat to local distribution grids. Projects implementing combined heat and power in micro scale have been present in other allocation categories, however these are eligible only in case of generating energy just for own purposes of the renovated building. Broader presence of the “Cogeneration” along with development of local heat distribution grids may also support elimination of the individual distributed boilers fed with coal as well as enforcement of the distributed power generation in the regions.

Detailed descriptions of the priority areas of the Regional Operational Programmes only in case of a few regions defined “umbrella projects”, which assumed financing the projects implemented by local governments and local associations aiming at thermal renovation of private residential housing. Formula of the project was being applied for implementation of projects assuming installation of solar collectors at private houses, within the Regional Operational Programmes in the period 2007-2013. Referring to the experience of the author, based on communication with local governments, the same formula will be used in the case of projects assuming local-scale implementation of photovoltaic systems. Implementation of the umbrella project requires establishment of the group of house owners willing to conduct the thermal renovation as well as capable of providing own input to the ERDF financing. Although a physical person is not eligible for ERDF financing, the umbrella projects are being prepared and implemented by formally established association, which remains owner of the installations of the investment throughout the period which is required to maintain the results of the project. Complexity of the umbrella project preparation results from the necessity of conducting energy audits for the involved members – owners of the houses. Project preparation processes, due to financial intensity related to preparation of energy audits for the members of local associations have not been spread in the regions.

Comparison of the funds allocated for residential housing with the funds assigned to enhance performance of public buildings reveals that in neither of the regions, funds assigned for residential housing have exceeded the funding for public buildings. Due to the fact, the numbers of private residential buildings exceed the number of the buildings owned or operated by public administration, the potential of ERDF financing may not be sufficiently utilized to reduce the environmental and health impacts resulting from emissions originating from private housing.

Besides the increased potential for thermal renovation of private family houses, availability of the ERDF funds, may also constitute a significant opportunity for the local governments responsible for securing social residential housing, either to conduct modernization of the currently owned resources or develop new social housing in accordance with energy efficiency standards required by the EU and national regulations. Formulation of the priority areas dedicated to sustainable energy, in most cases, did not allow precise assessment of the potential for the modernization of private and public buildings.

5. Conclusions
Availability of ERDF funding for energy efficiency constitutes tremendous opportunity for the sound improvement of the energy efficiency of the residential sector responsible for air pollution. In comparison to the funds available in the regions for the energy efficiency project significantly exceeds the funding which had been assigned for the improvement of buildings’ energy performance within the
state programme “Ryś”, developed by the National Fund for the Environmental Protection and Water Management. Funds allocated to the programme amounted to 400 million PLN (c.a. 95 million EUR), out of which 120 million PLN offered as grants, for the period 2015 – 2023 [27]. Effective distribution of the ERDF funds and completion of the investments within the period of few years, requires sound preparation of the conditions for the proper implementation of the programme. Preparatory processes include specifically establishment of local partnerships as well as conduction energy auditing of the local residential resources, which is also related to incurring significant costs, difficult to conducts especially for smaller cities and towns. Therefore, distribution of ERDF funding should have been preceded with a concerted action involving public administration at the central, regional and local levels.

Besides the broad publicity of the air pollution problem in Poland, new, privately-owned residential buildings without access to heat distribution grid are being equipped with the coal-fed boilers, which do not fulfil the standards set by the technical norms for boilers PN EN 303-5. The problem results from low prices of the boilers and the lack regulations prohibiting installation and exploitation of the low class boilers with manual feeders, fed with solid fuels [28]. Municipal authorities, creating local legally binding regulations, using their prerogatives in the field of spatial planning, possess relevant instruments to stem the process resulting in further contribution to local air pollution from the new but inefficient heat sources. Besides existing national regulations demanding energy performance standards for residential sector, lack of concerted action involving all levels of public administration threatens achievement of the assumed quantitative goals in reduction of air pollution.

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