

Asian Journal of
Applied
Sciences

Review Article

Review of the Role of Energy Agencies in Energy Efficiency of Public Lighting: Case Study Involving Three Agencies in Lisbon

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Abstract

This paper describes the contribution of energy and environment agencies to energy efficiency in public lighting. It is presented the evolution of public policies that made possible the state of evolution of energy public policies. The energy and environment agencies were promoted by the European Union. Since 1991, the energy agencies in Portugal have been created with the European Union Specific Action Vigorous Energy Efficiency program funding. European and Portuguese regulations that states energy efficiency are described. Three energy agencies are presented as case studies. The comparison among them resulted in some recommendations for the future. It was concluded that the agencies have a role to play in improving energy efficiency. They can expand their activities through partnerships with other stakeholders and improving their own legislation.

Key words: Energy efficiency, energy and environment agencies, public lighting, energy public policies, public policies

Citation: José Bustorff and Nuno Soares Domingues, 2018. Review of the role of energy agencies in energy efficiency of public lighting: case study involving three agencies in Lisbon. Asian J. Applied Sci., 11: 163-171.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Overnight public lighting (PL) policies play a key role in contributing to energy and cost efficiency, therefore to energy sustainability. The PL in primary and secondary urban roadways are of major importance to road traffic¹ when compared to secondary distribution roads, local roads and pedestrian paths and bicycle paths. The research has shown that the greater the risk of accident at night the greater the need for PL^{2,3}.

There are questions that need to be addressed at the same time as technology such as:

Energy agencies can become development hubs? To what extent will their work be possible within a public state system? What context is required for the agencies to contribute to energy efficiency? How energy agencies can be effective for public lighting energy efficiency and mobility? What are the mechanisms to improve cooperation and coordination between agencies and public organizations at the national, regional and municipal levels?

At this stage, this paper presents a review on current public policies of the energy sector; the creation of energy and environment agencies; the energy agencies in Portugal; three agencies from the Metropolitan Area of Lisbon are compared.

ENERGY AGENCIES IN ENERGY EFFICIENCY OF PUBLIC LIGHTING

The literature review was carried out on public policies in the energy sector, namely those related to external IP and

mobility. The review included the creation of energy and environment agencies in Portugal. Energy and environment agencies at the national, regional and municipal levels were studied. It was selected three of the agencies in the metropolitan area of Lisbon: one regional and two municipals. The main of the study focus was on energy efficiency and mobility since the agencies were created and was presented in Fig. 1.

Energy and environment agencies are presented by date of creation. The inventory of energy Portuguese agencies was based on Internet gathering information. The selection of the three case studies complied with the criteria: to belong to AML and to be regional or municipal.

Energy sector public policy: Energy and security have been the two sectors that reflect the major advances in public policies worldwide, including Portugal. The interest in public policies in general is relatively recent. From the 1980s onwards, they gained greater visibility. The public policy concept has not changed since Lasswell contributed to laying its foundations as an interdisciplinary movement that integrates knowledge of the social sciences with public action⁴. It is understood that public policy, according to Kraft and Furlong⁵ is a course of action or inaction of the government, in response to public problems. In fact, the State's omission against a given situation is also a public policy. It is the case of cost efficiency and environmental sustainability⁶⁻⁸. Public policies are State tools to govern⁶. They are laws, regulations, budgets, programs and projects⁹.

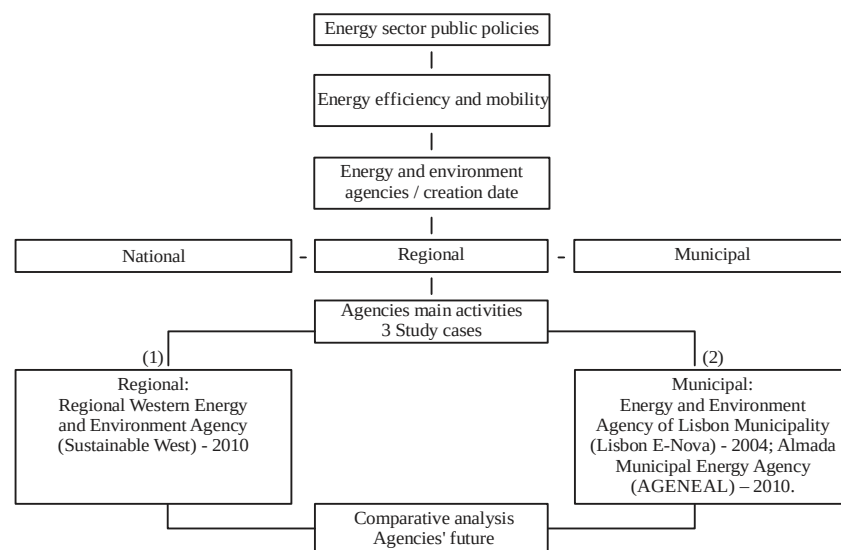


Fig. 1: Methodology

New views on the role of governments have been replacing post-war Keynesian policies for "restrictive spending" policies. The adoption of balanced budgets between revenue and expenditure at the search for efficiency has been implemented instead^{10,11}. Efficiency has come to be seen as the main objective of any public policy, coupled with the importance of credibility and the delegation of public policies to institutions with political independence¹⁰. The delegation to national independent bodies has become an important element in the design of public policies, due to their credibility, technical experience, stability and coherence in face of uncertainties of electoral cycles¹¹. This is a big change when compared to policy basis in the 1970s; it was focused on distribution and redistribution¹². According to Subirats, currently the legitimacy of government action is based more on the ability to respond to the needs of the sectors involved in various fields of action than on their theoretical ideological or constitutional legitimacy¹³. According to Chapman¹⁴, even if contemporary governments may have problems in the implementation of responsibilities, what counts is the identification of the type of problem to be corrected with public policy. More efficient choices in the electricity sector improve environment sustainability, therefore contributing to reduce budget deficits^{6,11}. Also, consumers, even though not yet fully considered in public policy, also contribute to budget deficits⁷; it is evident in the electric sector^{2,15-17}. Besides, the participation of the private sector is often a means by which the public sector is able to concrete the public policy; that is the case of IP projects that are awarded through open tenders.

For a public policy to govern requires: (a) articulation of a common set of priorities for society; (b) consistency; (c) direction; and (d) accountability¹⁰. According to the same researchers, the lack of well-conceived and functional means of accountability, democracy can have difficulties in maintaining commitments to the public.

Taking in account what has been said above, energy policy could be considered a case of "new management", with public-private participation, where efficiency is the "presentation card" of this policy closeness to citizens.

Energy sector evolution: The intensive use of energy because of exponential growth of land occupation and population are relatively recent phenomena occurring in the latter part of the 20th century. Its evolution has shown ups and downs stressed in European Union countries¹⁸.

In the second half of the 1950s, coal accounted for more than 50% of energy supply, relegating hydro power to a second place. Oil-then controlled by US and European

companies - entered the market progressively, while nuclear energy was developing. Governments participated more directly in the energy policy by nationalizing part of the energy industry after the Second World War¹⁴. The energy sector companies were considered strategic for national economy¹⁹. The year 1986 marked a turning point in the history of energy¹⁸. In fact, at the heart of the European Union, there were two organizations focused on energy, the European Coal and Steel Community and the European Atomic Energy Community²⁰. At the same time, Scheuer pointed out that the European Community had taken the first steps in environmental policy with a thematic and sectoral approach. Regulations were stated when the first Environmental Action Program of the European Communities²¹ was created. As a result, the energy sector has been reoriented since 1986, when the legislation that encouraged the diversification of energy sources was approved²⁰. In the same year, Portugal joined the European Economic Community: the XI Portuguese Constitutional Government Program (1987-91) came to advocate, for the first time, the use of natural resources for energy production²⁰. As consequence of economic growth, energy consumption in Portugal accelerated²⁰. Another important public policy factor that contributed to energy development occurred in 1988, when it went back to privatize a substantial part of the capital of energy companies nationalized in the past decades¹⁹. According to the Energy Services Regulatory Authority (ERSE), 2016, the beginning of market liberalization regulation in the energy sector in Portugal was established in the basic electric sector legislation of 1995 and the first European internal electricity market regulation of 1996. Regulation came about with the start of privatization of electricity companies and the liberalization of the electricity market. The regulator assumed a neutral and independent role vis-a-vis the agents and operators of the sector and the State itself (at that time, the majority shareholder in energy companies)²⁰.

Araujo and Coelho²⁰ pointed out that, at the European level, the decade of 2000 was dominated by the association of energy and climate policies, namely in the promotion of renewable energies, energy efficiency and the promotion of the use of biofuels. According to the same researchers, in 2008 the European Energy/Climate Package 20-20-20 was approved. It set the following targets to be met by all European Union (EU) Member States until 2020: (a) Reduction of 20% of greenhouse gas emissions compared to volumes issued in 1990; (b) about 20% increase in renewable energies in the energy mix and (c) 20% less energy consumption as a result of efficiency, plus the use of at least 10% of biofuels in transport (p.150). "In the same year, the National Action Plan

for Energy Efficiency was approved in Portugal. Its objective was the creation of necessary conditions for compliance with the EU Directive 2006/32/EC that sets efficiency objectives for energy end use and energy services. In 2010, the National Energy Strategy 2020 was approved, which integrated the commitments made under the European Energy/Climate Package for Portugal. The Strategy 2020 expects that by 2020, 60% of the electricity produced and 31% of the final energy consumption will have a renewable energy base and energy consumption will reduce by 20%. At the same time, measures were implemented to induce a change in the behavior of energy consumers, as the campaigns to replace incandescent bulbs with efficient bulbs.

Energy agencies: The EU support programs explicitly states that regional actors develop their projects on the basis of surveys of the local situation and the building of organizational and local structures²². Energy agencies emerged at the initiative of the European Commission, now called the European Union, through the Specific Action on Vigorous Energy Efficiency Program (SAVE). The SAVE program (1991) aimed to encourage rational and efficient use of energy resources and SAVE II (1997) aimed to improve energy efficiency. SAVE is part of a EU program formally approved in October 1991 for a period of five years (renewable for equal periods) to encourage energy efficiency within and outside the European Union. The SAVE program was implemented by the first Energy and Environment Agency created in the 1990s.

Also, in the early 1990s, Regional Development Agencies (RDA) were created. The RDA initiative came from the impulse of non-governmental organizations, specifically for the private sector, which included the development of infrastructures. The RDAs were expected to play a critical role in mobilizing support and funding for regional development projects. At both regional and local levels, the setting up of energy and environment agencies under the SAVE II program meant that local authorities and RDAs should play an important role in promoting Renewable Energy (RE) by mobilizing local partners with environmental expertise. RDAs were considered to fill serious gaps in the structure of regional economic development²². The economic development was accompanied by the need to increase PL due to new land use construction. The EU considered RDA as means to a more regional autonomy²³. RDAs are seen by the EU as the main vehicles for attracting large flows of financial resources. Besides, RDAs are expected to coordinate expenditure and to comply development national and international policies, such as the energy sector²². According to Lagendijk *et al.*²², the EU Lisbon Agenda (2000) gave an additional boost to cultivating

forms of territorial governance, especially at the regional level. The EU considers regional and local authorities and agencies as bridges to inform and involve citizens, local businesses and organizations. They are means for a "better government"²⁴. The agencies mainly serve to carry out administrative tasks under the authority of the Central Government²².

The role of energy and environment agencies has been a channel that allows all those who are connected to the energy sector, from producer to consumer, to exchange ideas. The goal has been the improvement of local energy efficiency actions; it has been essential factor in sustainable development. According to Turrell³ the main areas of activity that energy and environment agencies are focused on are: energy, environment, mobility and empowerment and accountability.

The first sustainable development steps were taking because of the Bruntland Report in 1987. It implied an increase in efficiency of the energy sector. Energy sources and normalization were key pre-defined strategies within the European objectives. The reference document for energy PL efficiency, DREEIP²⁵, was drawn up on the basis of the European Standard for Public Lighting, EN 13201, which sets out the technical parameters for the design of the PL installation projects. The DREEIP is a basic reference for the entities in charge of PL management to elaborate the municipal public lighting regulations and the public lighting director plans.

The DREEIP is the result of the activity of a working group constituted by the Association of Energy and Environment Agencies (RNAE), Network National Energy, Portuguese Lighting Center (CPI), Energy Agency (ADENE), National Association of Portuguese Municipalities (ANMP), EDP Distribution and Engineers College (OE). The group was an initiative of the Secretary of State for Energy in 2010.

In Portugal, PL accounts for 3% of total electricity consumption, being paid by municipalities and may exceed, in some cases, 50% of the budget (DREEIP, 2018). There are municipal and regional energy agencies that together with municipalities contribute to energy efficiency. DREEIP recommends Light Emitting Diode (LED) technology as the most innovative on the market.

The Portuguese Center for Energy Conservation (created by Decree No. 147/84, of May 10) was transformed into the Energy Agency AGEN by Decree no. 223/2000 of September 9 and modified by Decree No. 314/2001 of December 10, being renamed ADENE. Currently, ADENE is the national energy agency. This is a collective body of associative type. It carries out activities of public interest in the field of renewable energies and the rational use of energy (Decree No. 47/2015

of April 9)²⁶. ADENE also promotes and carries out activities of public interest in the areas of energy efficiency in mobility.

ADENE is financed by public entities with responsibilities in the areas of environment and energy and other concessionaires of public services (Decree No. 47/2015 of April 9)²⁶. The public service activities developed by ADENE are financed exclusively by public entities with energy attributions (Decree No. 47/2015 of April 9)²⁶. The DREEIP was updated in 2017 by the working group: CPI, ANMP, OE, the College of Technical Engineers (OTS) and the General Directorate of Energy and Geology (DGEG). The RNAE joined the group in 2010 to collaborate in the final revision of the new document.

Security, sustainability and accessibility have been central objectives of EU energy policies²⁷. By the year 2030, the goal is to double the overall rate of energy efficiency improvement²⁸, in which energy agencies play a key role.

CASE STUDY

The review showed that the EU SAVE program (1991) was responsible of creation of energy and environment agencies in Portugal. SAVE financed projects of EU member countries, as well as Brazil. The first energy agencies created in Portugal were the regional ones. From the list of the energy agencies

presented in Table 1, one of the first agencies created in 1993 was the Regional Energy and Environment Agency of the Autonomous Region of Madeira (AREVDN); at municipal level, the oldest municipal agency is the Sintra Municipal Energy Agency (AMES), which was created in 1997. The most recent agencies were created in the year of 2010, they are eight municipal and one national. The data source for dates of agency creation are available at <https://www.racius.com>.

In general, the mission of energy agencies is to: streamline local energy policy; provide useful and up-to-date information; promotion of energy management through the introduction of efficient technologies and the dissemination of good practice; promotion of renewable energies; promotion of a sustainable mobility policy; promote citizens' awareness of climate change; elaborate land use planning instruments, such as energy charts, mobility planning, PL planning (PDIL); development of action plans for energy efficiency (PAES/PAESC). The energy and environment agencies support other development agencies and according to Lagendijk *et al.*²², the only defined task is to support projects in regional plans implemented by other organizations.

Like other agencies in the country, the energy agencies of Lisbon region promote actions to stimulate energy and

Table 1: Some of the energy agencies created in Portugal between 1993 and 2010

Agency	Date of establishment
Regional Agency for Energy and Environment of the Autonomous Region of Madeira (AREVDN) 1993	1993
Regional ENERGY AGENCY OF VALE DOURO NORTE (AREVDN)	1996
Municipal Energy Agency of Sintra (AMES)	1997
Regional Energy- Environment Agency of Vale do Lima (AREALIMA)	1998
Regional Energy Agency of Centro e Baixo Alentejo (ARECBA)	1998
Regional Energy Agency of Lisbon (AMERLIS)	1998
Energy Agency of the South of the Metropolitan Area of Porto (ENERGAIA)	1999
Municipal Energy Agency of Almada (AGENEAL)	1999
Regional Energy-Environment Agency of Interior (ENERAREA)	2000
Regional Energy-Environment Agency of Centro (AREAC)	2003
Municipal Energy-Environment Agency of Oeiras (OEINERGE)	2003
Municipal Energy-Environment Agency of Lisbon (Lisbon E-Nova)	2004
Regional Energy-Environment Agency of Algarve (Quarteira) (AREAL)	2004
Municipal Energy Agency of Cascais (AMECASCAIS)	2005
Regional Energy-Environment Agency of the Autonomous Region of Açores (ARENA)	2006
Regional Energy Agency of Moita, Montijo e Alcochete municipalities (SENERGIA)	2006
Energy-Environment Agency of Arrábida (ENA)	2006
Energy Agency of Porto (AdEPorto)	2007
Regional Energy Agency of Barreiro, Moita and Montijo municipalities (S. energy)	2007
Regional Energy-Environment Agency of Norte Alentejano and Tejo (AREANA Tejo)	2009
Regional Energy-Environment Agency of Médio Tejo and Pinhal Interior Sul (MÉDIO TEJO 21)	2009
Municipal Energy-Environment Agency of Lisbon (LISBON E-NOVA)	2010
Municipal Energy Agency of de Almada (AMESEIXAL)	2010
Regional Energy-Environment Agency of Oeste (OESTE SUSTENTÁVEL)	2010
Energy Agency of Cávado (AECÁVADO)	2010
Energy Agency of Trás-os-Montes (AE-TM)	2010
Municipal Energy Agency of Almada (AGENEAL)	2010
Municipal Energy Agency of Seixal (AMESEIXAL)	2010
Associação de Agências de Energia e Ambiente (Rede Nacional)	2010

Source: Racius²⁹

environmental efficiency. They implement measures such as the total conversion to LED in Lisbon, the installation of PL Intelligent Systems for Management and the increasing of light points. Facing the energy efficiency requirements, the agencies have presented measures to reduce IP consumption. Some measures are: reprogramming astronomical clocks (turn on 20 min after sunset-turn off 30 min before sunrise); reduction of 8% of the average operating time by replacing 80 W metal vapor lamps (MV) with 50 W high pressure sodium vapor lamps (SAP); installation of LED lighting fixtures; teleconnection technology in all PL circuits to identify faults and set astronomical clocks; encourage the cadastre of lamps by EDP to follow up on their state of conservation. Besides, "The implementation of energy efficiency will be guaranteed by the partnership established among the RNAE and energy agencies that will be responsible for the dissemination of the measures to be applied to consumers"³⁰.

The modernization of Portugal is in the increase of energy efficiency. This increase in energy efficiency is essential to meet the goals set in the National Energy Strategy 2020: to reduce the country's energy dependence to 74% by 2020; to achieve the country's progressive independence from fossil fuels; to ensure compliance of European policies to combat

climate change, which includes energy efficiency³¹. In addition to the actions already mentioned in this document related to PL, the National Action Plan for Energy Efficiency (NAEE) was established to regulate PL³. According to the same author, the application of PL initiatives in the territory depends upon the municipalities. It is recommended the association among them to change at least 2000 points of light in each lamp replacement intervention.

As example, in 2007, the per capita expenditure of EDP PL for Almada agency was around €10, while the per capita expenditure for Lisbon and Porto³ was €1. According to Turrell³, since the energy billing of PL is often less than 1%, it led the municipalities to approve PL projects against the recommended values of Index Lumines.

ENERGY AGENCIES IN THE LISBON METROPOLITAN AREA

Regional energy agency: The "Oeste Sustentável Regional" Energy Agency was constituted on February 25, 2010 and its first action plan was presented in 2011. The agency inventoried 150.000 luminaries in the western area of Lisbon, the consumption was 74.715.423 Kwh expending 7.262.659 €. This agency proposed the complete replacement of PL-LED Intelligent SystemI based on a comparative analysis that justified the replacement of the lamps³². The estimation of energy efficiency benefits was presented in Table 2 showed that the energy agency's strategic action plan was a good measure for energy efficiency.

A comparison of energy efficiency of lamps was presented in Table 3 (adapted from Carvalho³² and Borralho¹).

The Expresso newspaper press release dated June 11, 2010, informed that the "Oeste Sustentável" Agency was responsible for placing that year 1500 astronomical clocks in the region. According to Carvalho³², 19.6 million euros were invested to replace half the public lighting in the region with efficient lamps, the largest investment in the country. That is, 70.000 of the 120.000 existing PL lamps were replaced in the 12 municipalities of the West region. They were substituted for more efficient ones.

Table 2: Estimation of energy efficiency benefits when replaced sodium and mercury vapor lamps with LED in the municipalities of the west region of Lisbon in 2009

Western area	Installed lights (KWh)	LED (kWh)
Alcobaça	11.387.612	4.555.045
Alenquer	6.990.750	2.796.300
Arruda dos Vinhos	2.452.001	980.801
Bombarral	2.880.452	1.152.181
Cadaval	2.683.898	1.073.559
Caldas da Rainha	10.866.139	4.346.455
Lourinhã	5.229.758	2.091.903
Nazaré	2.803.362	1.121.345
Óbidos	3264076	1305631
Peniche	5282259	2112904
Sobral	2117307	846923
Torres Vedras	18757809	7503124
TOTAL	74715423	29886171
	74 GWh	24 Gwh

Source: Carvalho³²

Table 3: Comparison of energy efficiency for three types of lamps

Indicators and benefits	LED lamps	High pressure sodium lamps	Mercury vapour metal halide lamps
Energy consumption (W)	80	150	138
System efficacy (Lm/W)	100	72	31
Life expectancy (h)	60000	20000-30000	6000-10000
Monthly expense (€)	2,21	4,86	4,47
Electric power (W)	1-5	50-1000	20-2000
Color temperature (K)	Different shades between 2000 and 8000	Yellow near 1800	Different white tones between 3000 and 6000
Color reproduction index	Very good	Enough	Excellent
Main advantages	Good energy efficiency, long life, low maintenance	Good energy efficiency, long life	High efficiency lighting
Main disadvantages	High cost, excessive heating reduces its durability	Poor color rendering	Durability not too high

Source: Carvalho³² and Borralho¹

Municipal energy agencies: Since the creation of Lisbon E-Nova and AGENEAL municipal energy agencies, they have developed activities related to outdoor PL together with the Local Power Company of each municipality. The Lisbon municipality in collaboration with Lisbon E-Nova has installed (2008) lighting sensors in Sete Rios to ensure that PL only works when it is strictly necessary²². In addition, conventional lamps were replaced for LED technology (very low consumption) at Parque Eduardo VII, Avenida da Liberdade and Bairro Alto. In 2009, Lisbon E-Nova carried out the LED Test in Parque Eduardo VII replacing temporarily some conventional luminaires (high pressure sodium vapor) for LED luminaires. The 2018 energy efficiency objective of E-Nova is the installation of 1000 electronic ballasts in lamps with 250 W for an annual savings of 381 MWh/year. The Municipality of Almada and AGENEAL reviewed the Municipal Master Plan of Almada (2011). They recommended that the accomplishment of the Master Plan requires the reinforcement of the Energy and Climate Package that established a reduction of CO₂ emissions by 2020. This objective improves energy efficiency by 20% compared to 1990³. Based on this information, it considered that indirectly AGENEAL contributed to the replacement of conventional lamps for LED lamps.

Three cases comparison: The three energy and environment agencies—"Oeste Sustentável", Lisbon "E-Nova" and AGENEAL agreed in replacing lights bulbs for LED because energy saving and environmental sustainability. It can be said that the replacement of lamps for LED technology has been a time-consuming work, occurring in phases, due to main disadvantages: high purchase cost, high cost in replacing sources and excessive heating reduces its durability. There is still a low height/distance between posts ratio¹.

The energy and environment agency that most information was gathered from was the Regional "Oeste Sustentável" Agency. Perhaps it is because it is a regional agency. Lisbon E-Nova compared to AGENEAL presents a better online image and it has been possible to identify more newspaper articles about their activities and projects. The best position in the medias could be a consequence of its earliest creation (2004).

According to Turrell³, all facts described above are essentially for consumption rather than production, promoting changes that contribute to mitigate climate change.

The PL is a continuous work that requires monitoring of the lighting systems of the various mobility routes, in addition

to investigations on PL efficiency. The work of the energy and environment agencies is seen as fundamental for the PL system improvement.

FUTURE OF AGENCY ACTIVITY

The revision of the legal framework of energy agencies and RDAs is necessary, for example, in the preparation of regional development strategies and regional plans²².

At the national level, energy agencies support initiatives related to financial support programs. Like the Plan to Promote the Efficiency of Electricity Consumption (PPEC) promoted by the Energy Services Regulatory Agency (ERSE); this plan facilitates the execution of projects promoted by RNAE in partnership with other public and private organizations. The energy agencies must continue to make the energy sector an investment priority in partnership with municipalities. This strategy should be articulated with the National Action Plan for Energy Efficiency (PNAEE), as it should be based on improving energy efficiency.

Partnership among energy and environment agencies appears to be key to successfully participate in EU programs, such as the Horizon 2020^{33,34}.

As other countries, such as Turkey, Portugal development agencies and the energy sector as a whole, are depending on decentralization to get a more regional autonomy, as advocated by the EU²³.

CONCLUSION

The type of energy problems at regional and municipal level can only be solved by systematically improving local "business" and organizational and institutional networking. Energy efficiency, in particular outdoor PL, has been part of the measures to mitigate climate change. The DREEIP is a guide document for stakeholders for energy management. It contains all the indications about PL management.

Replacing traditional light bulbs with LED bulbs has been one of the biggest national successes in terms of energy efficiency. Energy and environment agencies are part of the phased action plan for this achievement due to the high initial investment in technology that municipalities have to budget.

Although the investments in LED technology and electronic ballasts are high in the beginning, the return in energetic, environmental and economic terms compensates, like in the case of "Oeste Sustentável" Agency. Both the regional and municipal agencies, in particular the three

agencies compared in this document, have played an active role in contributing to energy efficiency of PL and mobility. They participate in projects to install more efficient technologies under the LED structural system.

SIGNIFICANCE STATEMENT

The study presents implemented solutions in different municipalities and gives critical analyses about the approaches. This work has never been done before and is crucial for future studies. Also, the paper reflects on the legislation effect allied with economic and technological focuses. This is important to evidence the role of Governments and decision makers in the evolution of projects. Finally, the paper enhances the importance of the energy agencies in the dynamization of local projects with major impacts.

REFERENCES

1. Borralho, A.J.P., 2009. Iluminacao publica em espaco urbano- Recomendacoes de referencia e aplicacao as Avenidas Novas em Lisboa. [Public lighting in urban space. Reference recommendations and application to New Avenues in Lisbon]. Master Thesis, University of Lisbon, Lisboa.
2. Domingues, N., 2018. The costs and inference of the non electric affairs in the electricity sector: The political costs. *Case Stud. Bus. Manage.*, 5: 50-59.
3. Turrell, J., 2009. III. Repensar os territorios a noite. [Rethink the territories at night]. *Provas agregacao 109*. [Proofing aggregation 109]. University of Lisbon. <http://www.repositorio.ul.pt/>.
4. Lasswell, H.D., 1970. The emerging conception of the policy sciences. *Policy Sci.*, 1: 3-14.
5. Kraft, M.E. and S.R. Furlong, 2012. *Public Policy: Politics, Analysis and Alternatives*. 4th Edn., Sage, London.
6. Bustorff, J. and N.S. Domingues, 2018. Public lighting in Portugal: Standardization and results. *Energy Res.*, 2: 158-169.
7. Domingues, N., R. Neves-Silva and J.J. de Melo, 2017. Decision making in the electricity sector using performance indicators. *Energy Ecol. Environ.*, 2: 60-84.
8. Gonzalez Plessmann, A.J., 2008. Politicas publicas con enfoque de derechos humanos: Una propuesta para su conceptualizacion. [Public policies with a human rights approach: A proposal for its conceptualization]. *Aportes Andinos* No. 23. <http://repositorionew.uasb.edu.ec/handle/10644/1022>.
9. Barco, C.A., 2014. A Abordagem Baseada em Direitos. O Que e e Como se Aplica as Politicas Publicas? [The Rights-Based Approach. What is it and How Does it Apply to Public Policies?]. In: *Direitos Humanos e Politicas Publicas. Manual*, Burgorgue-Larsen, L., A. Maues and B.E.S. Mojica (Eds.), Universitat Pompeu Fabra, Barcelona, ISBN: 978-84-697-2160-5, pp: 49-76.
10. Pierre, J. and B. Peters, 2005. *Governing Complex Societies: Trajectories and Scenarios*. Palgrave Macmillan UK.
11. Souza, C., 2006. Politicas publicas: Uma revisao da literatura. [Public policies: A review of the literature]. *Sociologias Porto Alegre*, 8: 20-45.
12. Lowi, T.J., 1972. Four systems of policy, politics and choice. *Public Admin. Rev.*, 32: 298-310.
13. Subirats, J., 1992. Analisis de Politicas Publicas y Eficacia de la Administracion. [Analysis of Public Policies and Effectiveness of the Administration]. Ministerio Para Las Administraciones Publicas, Madrid, ISBN: 84-7088-611-8.
14. Chapman, R.A., 2001. Viewpoints: Ethics in public service for the new millennium. *Public Money Manage.*, 21: 6-7.
15. Domingues, N., 2009. Influence of the renewable energy in the simulation of liberalised markets. *Proceedings of the International Joint Conference on Computational Sciences and Optimization*, April 24-26, 2009, Sanya, Hainan, China, pp: 480-484.
16. Nuno, D., 2018. Background studies to tackle environmental problems: On solar projects in Portugal. *Environ. Anal. Ecol. Stud.*, Vol. 1, No. 3. 10.31031/EAES.2018.01.000513
17. Domingues, N., R. Neves-Silva and J.J. de Melo, 2012. Accounting instruments of governance. *Proceedings of the International Conference on Smart Grid Technology, Economics and Policies (SG-Tep)*, Nuremberg, Germany, December 3-4, 2012, IEEE, USA., pp: 1-5.
18. Sierra, J., 2006. Una historia atormentada: La energia en Europa. [A tormented history: Energy in Europe]. *Inf. Comer. Esp.*, 831: 285-296.
19. Silva, S.M.C.L.T., 2011. *Direito da Energia*. Coimbra Editora- Wolters Kluwer, Coimbra.
20. Araujo, L. and M.J. Coelho, 2013. Politicas publicas de energia e ambiente: Rumo a um pais sustentavel? [Public energy and environment policies: Towards a sustainable country?]. *Sociol. Probl. E. Praticas*, 72: 145-158.
21. Scheuer, S., 2005. *EU Environmental Policy Handbook: A Critical Analysis of EU Environmental Legislation*. International Books, Netherlands.
22. Lagendijk, A., S. Kayasu and S. Yasar, 2009. The role of regional development agencies in Turkey: From implementing EU directives to supporting regional business communities? *Eur. Urban Regional Stud.*, 16: 383-396.

23. Loewendahl-Ertugal, E., 2005. Europeanisation of regional policy and regional governance: The case of Turkey. *Eur. Polit. Econ. Rev.*, 3: 18-53.
24. Gualini, E., 2004. Regionalization as 'experimental regionalism': The rescaling of territorial policy making in Germany. *Int. J. Urban Regional Res.*, 28: 329-353.
25. DREEIP., 2018. Eficiencia energetica na iluminacao publica. Documento de referencia. PARTE II-Projeto de Iluminacao Publica-Especificacoes. [Public lighting project-specifications]. http://www.rnae.pt/download/DREEIP_Partell.pdf.
26. Republic Diary, 2015. RPS No. 47/2015. April 9, 2015
27. Sarmiento, M. and D. Durao, 2003. Contribution of natural gas for sustainable development in Portugal. *Rev. Gestao Tecnol.*, Vol. 2, No. 1. 10.20397/2177-6652/2003.v2i1.132
28. INE., 2018. Objectivos de desenvolvimento sustentavel-Indicadores para Portugal. Agenda 2030. [Sustainable development objectives-Indicators for Portugal. Agenda 2030]. <https://www.unescoportugal.mne.pt/pt/noticias/ine-objectivos-de-desenvolvimento-sustentavel-indicadores-para-portugal-agenda-2030>.
29. Raciuss, 2018. Informacao empresarial. [Business information]. <https://www.raciuss.com/>.
30. Entidade Reguladora dos Servicos Energeticos, 2016. A Regulacao da Energia em Portugal 2007-2017. [The Regulation of Energy in Portugal 2007-2017]. Entidade Reguladora dos Servicos Energeticos, Lisboa, ISBN: 978-989-20-6883-1.
31. Pacesila, M., S.G. Burcea and S.E. Colesca, 2016. Analysis of renewable energies in European Union. *Renewable Sustainable Energy Rev.*, 56: 156-170.
32. Carvalho, M.S., 2011. A inovacao na iluminacao publica para oeste sustentavel. [Innovation in public lighting for sustainable west]. Oeste Sustentavel AgEncia Reg. Energ. E Ambiente Oeste. http://www.oestecim.pt/_uploads/Apresentacao.pdf.
33. Diakaki, C., E. Grigoroudis and D. Kolokotsa, 2008. Towards a multi-objective optimization approach for improving energy efficiency in buildings. *Energy Build.*, 40: 1747-1754.
34. Rodrigues, T.F. and A. Campos, 2017. Alternative energy in the EU: Lessons from Portugal. *J. Int. Scient. Public.*, 11: 1-17.