The Pentagonal Problem and the Offshore Energy Sector in Portugal: Why Does It Matter?

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Abstract The relationship between circular economy and offshore energy is a big step for "eco-innovation industries." The use of renewables has become one of the main issues in the European economy. Therefore, the latest European agenda for 2020 set up policies in order to implement new business models based on sustainability, cooperation, and collaboration between industries, towards more environment efficiency. This article shows the importance of offshore energy in Portugal and its linkages to a circular economy based on technology and innovation where natural recourses comprise a business model based on natural innovation system which performs a new method of analyzing the economy. The methodology will be based on the pentagonal problem (resources gap, technical challenges, public challenges, climate change challenges, problem statement) focusing on the Portuguese organizations which use renewable energy. In order to analyze the offshore energy sector, a quantitative analysis (IO matrix) and a qualitative analysis (Porter's model) are used. The use of renewable in the circular economy is expected to have an impact on three main areas: economic, environmental, and communal. The sharing of economic savings and collaborative consumption between organizations will contribute to redistribution markets and collaborative lifestyle platforms. The new challenge is to move towards a new business model based on eco-products, service providers, and energy recovery.

Keywords Circular economy · Offshore energy cluster · Pentagram problem · Innovation ecosystem

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1 Introduction

The world is changing towards a better use of renewable and environment resources.

Changing attitudes and valuing natural resources is the biggest step for economies. Circular economy provides a framework to face challenges and a guide for rethinking and redesigning the future. Therefore, in the global economy, the challenge is to prove the benefits of belonging to a circular economy and natural innovation system.

Circular economy underlines a few points which organizations face: the value added from circular products, reusing materials to reduce waste, the use of raw materials, forward and reverse logistics, supply chain efficiency, and innovative materials for innovative products (e.g. bio-based materials) (MacArthur and MackKinsey & Company 2014) from innovative ecosystems (Oh et al. 2016).

The linkage between circular economies and renewable energy will decrease the direct costs for production. Renewable energy offers effective technologies to tackle global energy challenges: climate change, the rising demand for energy, and the security of energy supplies (Zhang and Cooke 2009).

The challenge is to describe the linkages between offshore energy and circular economy and to set up a business model where market strategies can be put into practice towards more economy efficiency based on product performance, value added, and potential savings by sharing materials. The key is to create positive externalities in the economy to obtain more efficiency and competitiveness based on a business model where innovation and technology allows better natural resources uses.

The business model created by these vectors will promote innovation and networking in labor, products, and capital, having the pentagonal problem in consideration.

Another challenge for entrepreneurs, related with renewable energy and externalities in the circular economy value chain, is the capacity of the organizations to go forward and introduce new methodologies for the production of raw materials. This means changing the production process, making new investments, and finding market value for eco products.

This paper tries to analyze the potential of the Portuguese circular economy market when using offshore renewable energy, based on solving the pentagonal problem. The solution is still very incipient since the supply of offshore energy to the demand market is only an emerging cluster, (Pego et al. 2016) and also because few organizations are adopting the circular economy model for their businesses.

2 The Business Model and The Circular Economy

Innovation constitutes a problem in a modern economy related with new products, such as eco innovation, eco technologies, and a new process for production. The innovation problem derives from the concept of more sustainability and new challenges for production.

The natural innovation systems concept is the linkage between the innovation, technology, and multi-stakeholders collaboration (Oh et al. 2016). The circular economy is the concept where these relationships happen.

The circular economy (CE) refers to the industrial character of the economy, which becomes self-sustainable through the use of renewable energy, and there duction of toxic substances and waste (Costea-Dunarintu 2016: 150).

The concept of CE (Su et al. 2013; Lieder and Rashid 2016) presented in fig 1 is well known for the transition, which allows materials to safely re-enter the biosphere or continue to circulate as high-quality production resources; the opposite of a linear model where the 'take, make and dispose' is applied. The CE model is consistent with three aspects: environmental impact, economics benefits and resource scarcity. The question is solve the amount of waste substances and give them utility.

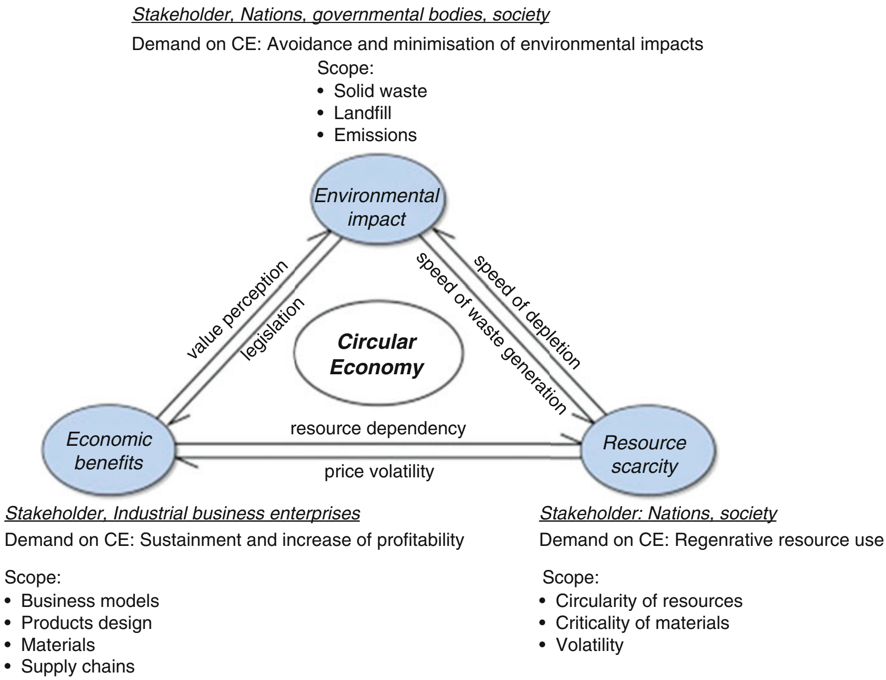

Fig. 1 A comprehensive circular economy framework. Source: Lieder and Rashid (2016: 45)

2.1 The Business Model

The concept of business model is based on industrial innovation of the future productivity and competitiveness between organizations. Di Fonzo and Hime (2017: 15) point out some features of the business models based on CE, such as decision-making support for business, measure and value decision-making, regulators, and research funders.

The CE business model solution can be improved if the companies transfer knowledge from their previous experience based on the relationship with costumers and stakeholders (Oh et al. 2016), monetizing capacity, having better control of the product life cycle, and creating stable revenue streams and premiums (MacArthur and MackKinsey & Company 2014: 47).

CE provides four types of resource benefits: improving resource security and decreasing import dependency; Environmental benefits: less environmental impact; Economic benefits: opportunities for economic growth and innovation; and Social benefits: sustainable consumer behavior and job opportunities (EEA 2016: 13).

The potential gaps to address include: the development of more accurate metrics i.e. regional rather than global and country level data; improved biodiversity and soil metrics (through consideration of relevant definitions and ways to report changes in context); strengthening the linkage between any suggested metrics and core business processes (Di Fonzo and Hime 2017: 23).

On the other hand, the network system and the potential for collaborative markets constitute the goal of CE system (MacArthur and MackKinsey & Company 2014: 39).

Further researches in this field can be based on top-down (legislation and policy, support infrastructure, social awareness) or bottom-up (collaborative business models, product design, and supply chain, information and communication technology) approaches (Lieder and Rashid 2016: 47).

Another perspective put forward by Genovese et al. (2017: 355), reveals that there are four types of regions with competitiveness and sustainability in CE. The transition to CE includes a new challenge involving political, cultural, human, and economic structures, as well as technological limitations. In the authors' perspective, there are four types of sustainability systems: Type IV (products) is a subset of System Type III (Businesses) which in turn is a sub-set of System Type II (Regions/ Cities). An aggregation of regions and cities then forms System Type I (The Earth).

Therefore, the business model based on this methodology is consistent with sustainable solutions at the product level, and it can be aggregated across businesses in order to improve their sustainability, as well as economic systems. This means a new challenge to improve business based on ecosystems and human well-being. The business models can be reliable with natural ecosystems projects, "systems thinking", shape ideias of technopolis and innovation, high-tech regional economic development, geographic activities location, and knowlodge from biological systems (Oh et al. 2016: 5).

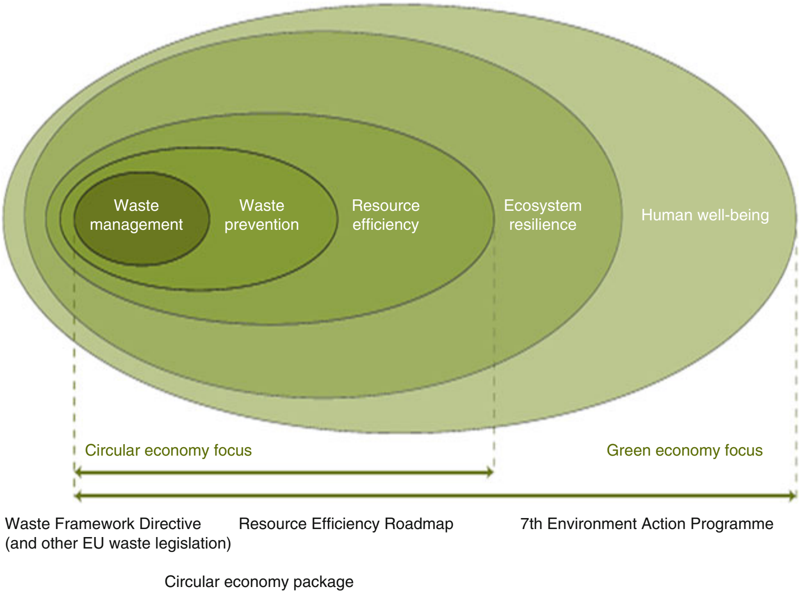

Fig. 2 Circular economy and green economy. Source: EEA (2016: 31)

Moreover, a business strategy based on CE needs to optimize materials and energy flows inside the regions or industrial ecosystems. This raises a new challenge for resource recovery and tax exemption policy for companies involved in reverse supply chain activities. Additionally, the expectation stakeholder's expectations regarding the CE business based on production, value chain and competiveness constitute an important vector for social, environment and resources efficiency in economy (Fig. 2).

Action plans and strategic directions are the vectors for the future of CE in Europe. Nevertheless, some technical, social, political and economic barriers are pointed out: companies are often not aware or do not have the ability or the knowledge to choose circular economy solutions; systems, infrastructures, business models and technology of today can lock the economy into a linear model; investments in efficiency measures or innovative business models remain insufficient and are considered risky and complicated; the demand for sustainable products and services can remain low, especially if they involve changes in behavior; often, the prices reflect actual costs incurred by the company for the consumption of resources and energy; the signals of political transition to a circular economy are not strong enough and consistent (Costea-Dunarintu 2016: 158).

The business model presented in this paper is completed if considering the Portuguese strategy for the sea and the emergent topic on innovation systems. Therefore, the Portuguese pentagonal problem of offshore energy relays on the strategy for the maritime economy (OECD 2016: 21) and the potentiality of innovation ecosystems. SEA has the capacity to understand the decisional and development context and to drive development opportunities into pathways that are inclusive of environmental and sustainability priorities (Partidário and Gomes 2013: 36). This means a relationship between a few vectors which comprise the environmental system and its linkage to a circular economy. Those vectors are the ecosystem services, governance, drivers of change and human well-being (Partidário and Gomes 2013: 39).

The Portuguese strategy to achieve an environmental performance is National Strategy for Integrated Coastal Zone Management (SICZM) (December 2008) and Maritime spatial Plan (MSP) (June 2009). In terms of ecosystems performance and its relation to the SEA activities, both apply for a better use of natural resources, where on SICZM the ecosystem approach is related with sustainable management of human activities that ensure the integrity of ecological systems and the valorization of ecosystem services; the MSP applies for Ecosystem Services related to evaluation of the ability to provide ecosystem services, taking into account thresholds of acceptable change with coordination and multi-purpose logic (Partidário and Gomes 2013: 40).

To sum up, despite the problems which arise from the pentagonal problem, the innovation ecosystem supports the ability to supply services and technology based on innovation towards more competitiveness between the multi-stakeholders.

2.2 *The CE Benefits on Economy*

EASAB (2015: 4) point out some benefits of CE: fostering competitiveness by creating savings and reducing raw materials and energy dependency; security of supply and control of rising costs; contributing to EU climate change policy by reducing greenhouse gas emissions; employment opportunities; reducing environmental impact of resource extraction and waste disposal; opportunities for new businesses by selling goods or offering services.

The following table shows the indicators for the study of CE.

Table 1 Indicators of circularity in an economy

Scope	Indicator
Resource productivity	GDP per kilogram of domestic material consumption
Circular activities	Recycling rate Eco-innovation index (index of green investment, employment, patents, etc.)
Waste generation	Amount of waste per GDP output Amount of municipal waste per capita
Energy and greenhouse emission	Share of renewable energy Greenhouse gas emission per GDP output

Source: EASAB (2015: 10)

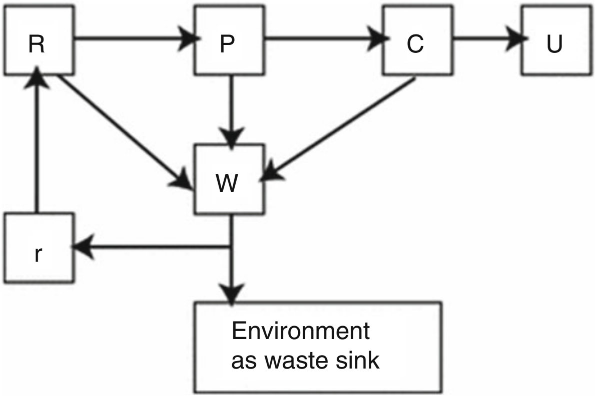

Fig. 3 The simplified circular economy. *r* Recycling, *W* waste, *P* production, *C* consumption, *K* capital goods, *U* utility, *R* natural resources. Source: Andersen (2007: 134)

One of the vectors to analyze circularity and its benefits on economy is the share of renewable energy and greenhouse gas emission per GDP output; additionally, to complete the analysis other factors need to be considered (Table 1).

Consequently, studying offshore energy and its linkages to CE value chain and direct or indirect impact is one of the advantages to study the relationship between production and value added on the economy. A better comparison can be achieved if the values for CE and linear economy or efficiency, competiveness, value added and environment impacts are compared.

Energy savings represent an essential component of meeting climate goals, and energy management is an unparalleled opportunity to enable organizations across all sectors to achieve on-going energy consumption reductions. This shift from a focus on the merits of individual projects to a more systematic, comprehensive, and strategic focus can enable organizations to develop their full potential to achieve improved energy performance overtime. Accomplishing this goal would enhance economic development at the organizational, national, and global levels, and would contribute greatly to address urgent global concerns regarding emissions from the use of non-renewable energy sources and associated climate change impact (EMES 2017: 7).

The importance of CE in the economic system is consistent with the relationship between economic agents, as shown in fig 3. The relationship between economic agents performs the direct inputs and outputs where the impacts on the economic system can be explored.

The analogy with renewables is quite easy to understand if we consider the overall benefits on the economic system. The system with renewable energy will promote the recycling of goods that will not be wasted because resources, economic agents and resources use are maximized with the minimum of waste. From this perspective, the environment can be acknowledged as fulfilling four basic welfare economic functions: (1) amenity values; (2) a resource base for the economy; (3) a sink for residual flows; (4) a life-support system (Andersen 2007: 135) (Fig. 4).

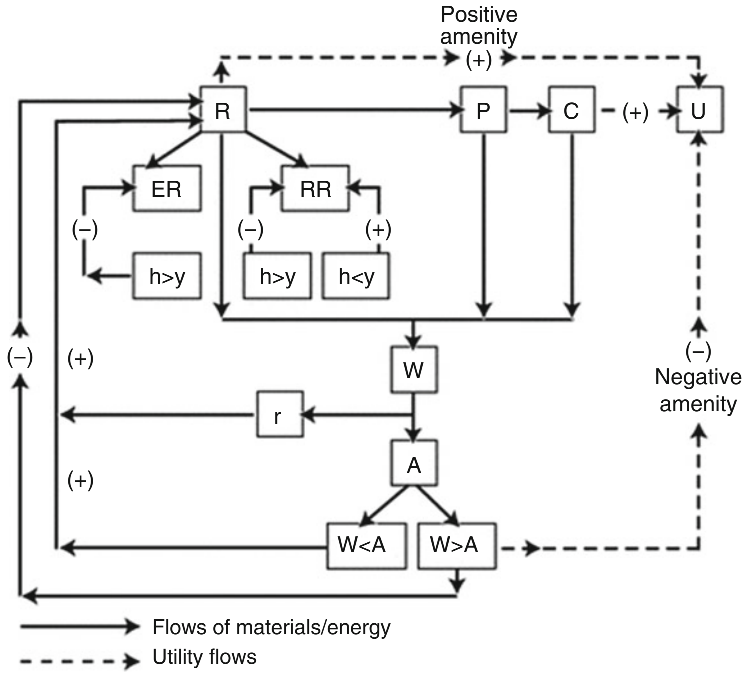

Fig. 4 The circular economy. *P* production, *C* consumption, *K* capital goods, *U* utility, *R* natural resources, *r* recycling, *W* waste, *ER* exhaustible resources, *RR* recyclable resources, *A* assimilative capacity, *h* harvest, *y* yield. Source: Andersen (2007: 136)

In other words, CE is a concept which involves a set of competences, useful for the welfare. This means a network with the ability to foster system thinking, goals, strategy and their adoption, with external and internal effects, and which promotes positive externalities in the economy.

Renewable energy is considered in this system as a factor which allows for the minimization of wastes and external costs.

The previous model is applicable to interaction between all sectors in the economy and CE. The model gives the idea of interaction and externalities which come from all sectors.

This means that CE, in a cumulative way, can be a positive externality when there are flows of material/energy between sectors. For this reason, the CE components are the positive vectors which allow linear economy for resource savings.

To sum up, the importance of CE in the business model is related with the capacity of the organization to provide externalities to the economy. The value-added generated by the symbioses of different sectors in CE promotes different levels of waste.

3 The Cleantech Model

The word Cleantech (green) is the new concept of clean energy, and it is related to transport; recycling &waste; materials; building & energy efficiency; renewable energy; air, water environment; agriculture & food sectors (Henriksen et al. 2012: 18). Cleantech is defined as (clean technology) products and services that use technology to compete for favourable price and performance while reducing pollution, waste, and use of natural resources (Burtis et al. 2004: 11). The table 2 shows the industries and the materials which apply for cleantech model.

The main areas involving cleantech are : *renewable energy* (Onshore, Offshore Wind, Solar, Geothermal and Bioenergy); *clean cities* (Green Buildings, Clean Water, Smart Grid, Solid Waste, Clean Road Transport) and *perspectives* (Maritime Cleantech, Carbon Storage, Energy Storage) (Cluster 2012: 10).

The Cleantech capacity involves regions, markets, consumers and renewable energy, as the niche activities, which are directly related to regional development,

Table 2 Cleantech industries category

Industry	Examples
• Advanced Materials and Nanotechnology	• Non-platinum catalysts for catalytic converters • Nano-materials for more efficient and fungible solar photovoltaic panels;
• Agriculture and Nutrition	• Innovative plant technologies and modified crops • Designed to reduce reliance on pesticides or fungicides
• Air Quality	• Stationary and mobile emission scrubbers • Testing and compliance services
• Consumer Products	• Biodegradable plastic ware • Nontoxic household cleaners
• Enabling Technologies and Services	• Advanced materials research services • High throughput screening research equipment;
• *Energy Generation, Storage, and Infrastructure*	• *Solar photovoltaic technology* • *Wind power* • *Hydrogen generation* • *Batteries and power management technology*
• Environmental Information Technology	• Regulatory and policy compliance software • Geographic Information Services (GIS)
• Manufacturing/Industrial Technologies	• Hardware and software to increase manufacturing productivity and efficiency
• Materials Recovering and Recycling	• Chemical recovery and reprocessing in industrial Manufacturing • Remanufacturing
• Transportation and Logistics	• Fuel cells for cars • Diesel retrofits equipment • Hybrid electric systems for cars, buses, and trucks
• Waste and Water Purification and Management	• Biological and chemical processes for water and waste purification • Fluid flow metering technology

socio-technical transitions in organizations, coordinated activities, and institutional involvement (McCauley and Stephens 2012).

Few institutions developed Cleantech studies [e.g. Finland (2014) and Henriksen et al. 2012)] in order to classify methodologies about renewable energy. Cleantech clusters comprise benefits, such as: the specialization of regions in activities, higher employment and greater expansion rates, reducing the cost of production and the cost of exchanging by strengthening trading relationships, local knowledge spill-over, local R&D institutions, business collaboration and research activities, and strong clusters in the same geographical region (Davies 2013: 1289).

In this paper, we point out three main models which show the linkages within the cleantech cluster based on offshore energy and the possibility of a relationship with CE model.

The *Helix Model* (Finland 2014: 6) combines five points: costumers needs, enterprise/private sector, coordination of cooperation, education and research and public sector. The goal is to develop strategies in order to maximize the cooperation between all sectors of the economy, through an innovative business where the needs of the market, Government, research, and networking are combined.

The *Convas Model* is usedto understand green business models and green business innovation. This model is based on eleven factors: growth strategy, key partners, key activities, key resources, value proposition, costumer's relationships, costumers segments, channels, cost structure, revenue streams, and comparative strategy (Henriksen et al. 2012: 33).

The *Diamond Model* comprising the analysis of collaboration and competitiveness between organizations towards a cluster was presented by Porter (1990). Maxoulis et al. (2007), Zhao et al. (2011), Dögl et al. (2012), and Monteiro et al. (2013). A diamond model is used to explain the competitiveness of economies for renewables through demand conditions, factors conditions, firm strategy structure and rivalry, and related and supported industries.

To summarize, the use of each model in green clusters where CE acts constitute an important issue in the green market, since it will promote organization competitiveness, maximized consumers utility, and innovation and collaboration.

4 The Impact of Offshore Energy in Portugal

The first study made on the impact of offshore energy in Portugal presented by Pego et al. (2016) concludes that there is an emerging sector. The study reflects also the direct, indirect, and induced effect on economy.

Most of the authors (Benito et al. 2003; Wijnolst 2006), agree that a good indicator of a cluster's relevance can be assessed by analyzing the strength of the connections (agglomeration economies) between its members, namely by the trade transaction figures that are at stake. In general terms, sectors in a successful cluster have a strong dependence on one another and on the way buyers and suppliers are related. In fact, there is a debate on whether it is more important to have these

Table 3 Suppliers with higher technical coefficients

NACE	Industry	Technical coefficients
351	Electr. Prod.	0.45
352	Gas Distr.	0.06
69 + 70 + 71	Services (Law, Manag, Archit.)	0.03
64	Financial Serv.	0.02
27	Electric Equip.	0.01
33	Mach &Eq Services	0.01
42	Civil Engin.	0.01
82	Other Serv.	0.01

Table 4 Energy production (351) Keynesian multipliers

Multiplier type 1 (output)	Multiplier type 2 (output)	Employment multiplier
2.53	3.18	2.11

connections between the same or different sectors (Titze et al. 2011; Boschma et al. 2012; Van der Panne 2004), with the majority of the later studies arguing that the development of clusters benefits more from a larger range of activities.

On the other hand, Nooteboom et al. (2007) argue that spillovers are more fruitful between sectors that are neither too cognitive close or distant.

The study presented by Pego et al. (2016) shown that there is a few linkages between the electric sectors which revels a potential clusters.

Results show that sector 351 (Electric power generation, transmission, and distribution) has a strong relationship with itself (6400 million euros of intra-commercial relations) (Table 3).

This is probably due to the large size of the main company and the concentration of activities (energy production, distribution and commercialisation). Taking into account all the 97 sectors' technical coefficients of the Leontief matrix [a_{ij}], we may conclude that there are just a small number of "average linkages" (technical coefficient >0.02) between "Energy Production" and the rest of the economy .

The direct and indirect impact from the offshore energy sector was estimated with a Keynesian multiplier (Pego et al. 2016).

Taking into account the e Windfloat investment (2011), in an amount of about 23 million euros had 58.2 million euros of direct and indirect effects and 73.1 million euros of total (direct + indirect + induced) effects. In what concerns the effects on employment, we cannot add a number, as the number of workers at Windfloat is not available. The table 4 shows the keynesian multiplier for energy production in Portugal for investments. Therefore, the investment and employment will increase substancially in the renewable offshore energy sector.

5 The Pentagonal Model

The pentagonal problem on sustainable economies became very popular for facilitators. This means that a new vision of CE and its future started to be discussed by stakeholders which are part of the CE. For this reason, the CE problem starts with a question *who are we?*(Matti et al. 2016).

The study presented by Moser and Ekstrom (2010) about climate changes and its impact on the economy, shows that there are a few points that society is dealing with. This means a new concept of planning and explores new challenges for *climate problem and economy*, related to understanding, planning and managing barriers. Consequently, the main concept is the transition, where the plan for excellence within a collective, an organization or a sector is broadly defined.

The pentagonal problem is also related to natural resources sustainability and consumer's needs. The optimization of renewable resources and its linkages to an organization is the "perfect marriage" if there is an adequate exploitation of natural resources and market needs by Cleantech organizations.

Therefore, smart grid technologies, low impact on the transportation system, stimulating local and regional economic development by creating the conditions that attract and promote innovative firms can be seen as the vectors of Cleantech performance in regions (McCauley and Stephens 2012; Lam et al. 2011).

In this paper, the relationship between the pentagonal problem and offshore energy towards a sustainable business model is discussed.

The IWA (2016: 13) report shows that there is a tight linkage between renewables and the environment. This means that energy and carbon strategies should be centered around reducing costs for customers and minimizing the impact on the environment. The energy portfolio should aim at reducing carbon-based energy consumption, increasing renewable energy consumption, increasing renewable energy production, and making a positive contribution to zero-carbon cities.

For this reason, studying the renewable energy path towards more sustainability in economy is one of the main achievements to solve the pentagonal problem.

Therefore, the innovative business model is globally accepted when there are important linkages between the vectors which are part of the CE.

6 Why Does the Pentagonal Solution Matter in the Portuguese Offshore Energy?

The emerging offshore energy sector in Portugal (2017) is the first pre-commercial phase for this type of energy.

Porter's diamond model makes possible for some conclusions on the potential of the supply sector. The study presented by Pego et al. (2016) points out the existence of virtually all the conditions for a swift development of an offshore energy cluster.

According to Pego et al. (2016), we may conclude that the first study made on the offshore energy cluster with Porter's methodology will lead to a competitive sector with a collaborative performance. Although, it did not study the linkages between the capacities of stakeholders to change their business model to a better performance based on environment and CE model.

For this reason, a new vision about the stakeholders and their ability to develop instruments based on climate change, business strategy, collaboration with others sectors is presented, with the following vectors: (1) *problem statement*; (2) *climate change challenges*; (3) *societal challenges*; (4) *technical challenges and* (5) *resources gap* (Matti et al. 2016).

The business strategy relies on a very simple way to solve a pentagonal problem regarding offshore energy. Firstly, the awareness of the stakeholders which are part of the energy sector and its linkages with one another; secondly, the very problem of the interaction on the cluster, which means better support to help business and prevent offshore business to flooding in the future; climate change can lead to lower profit of offshore investments; commercial insurance of offshore energy supply, and government help to the cluster towards more competitiveness and collaboration with other aggregated sectors, with financial and employment benefits; renewable energy is not mainstream, it needs technology, development, and research; lack of technical human resources and private financial support.

The importance of the pentagonal problem is based on a set of skills gathered to develop the offshore cluster project, and therefore circular economy projects (Fig. 5). Those are implemented taking in account more innovation and technology towards human well-being

The figure shows the capacity of offshore energy projects to become important in CE. The big challenge for the current business model is the capacity of offshore energy projects to be linked to CE in Portugal.

Solving the pentagonal problem is the basis for the change of the Portuguese business model towards a market strategy. This involves the implementation of environmental solutions, contributing positively to CE, cooperation with other environment-friendly organizations, innovation, expertise network, public interest, and intensive R&D activities.

Additionally, the importance of an agreement on a business model for offshore energy related with CE and the potential economic impact constitute an important point for organizations.

Therefore, solving the pentagonal problem for offshore energy in Portugal will allow for the identification of benefits and catalyzing enabling mechanisms focusing on five key areas of economic and environmental impact: material inputs, labor inputs, energy inputs, carbon emissions, and the balance of trade. Additionally, using a "circularity calculator" it is possible to compare the inputs needed to make a new product in today's linear system with those required to make the same product using pure materials flow (MacArthur and MackKinsey & Company 2014: 53).

For this reason, the Portuguese business model based on offshore energy development can be applied to public-private partnerships on innovative solutions, simultaneously developing a networking platform to foster the global agenda on science,

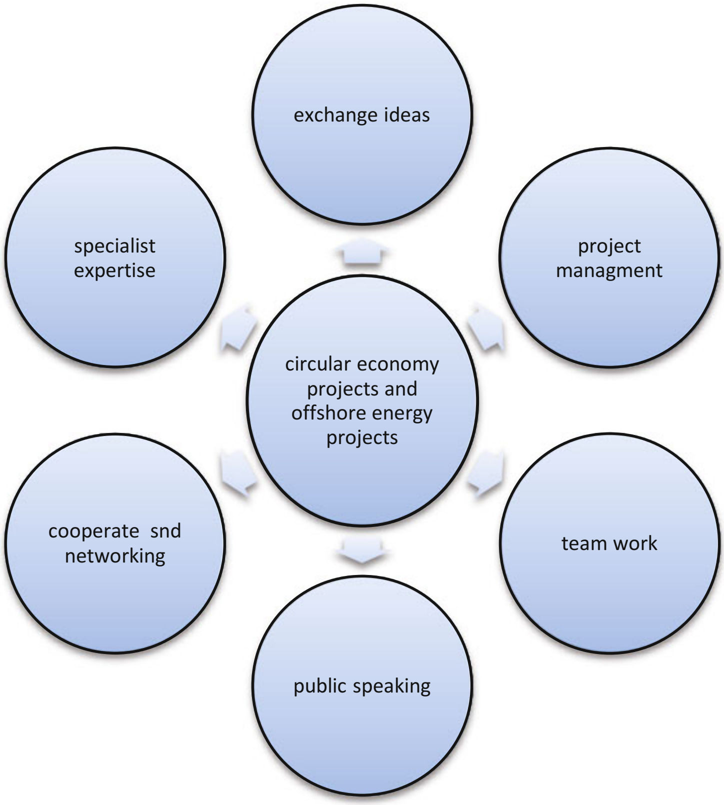

Fig. 5 Offshore energy projects and circular economy

technology, and innovation (innovation ecosystems). The goal is to find a solution for the pentagonal problem and address new challenges on business with synergies between the partners. Another point of view stressed the importance of information technologies (IT) in CE. Its trace the materials and products, organizing reverse logistics and accelerating innovation and technology (ecosystems). CE is one of the challenges for Portuguese business networking and for the emerging offshore cluster. Others like smart cities, sustainability buildings, and eco production will also bring up new challenges.

7 Conclusions

The interest of considering CE together with offshore energy is becoming more attractive bearing in mind the benefits of potential economic externalities. Thus, the analysis made along this paper showed that there is a positive economic impact from using renewables in green economy. Therefore, resources productivity, circular activities, waste generation and greenhouse emissions constitute important vectors for studying this relationship.

Considering the positive impact of offshore energy sector in Portugal (Pego et al. 2016), Porters' cleantech model, and the pentagonal problem related with CE and offshore energy projects in Portugal, this paper concluded that organizations face an important change towards a market strategy based on materials, labor, energy inputs, and natural innovation ecosystems. This means changing attitudes towards innovation and technology through new business from CE.

References

Andersen, M. S. (2007). An introductory note on the environmental economics of the circular economy. *Sustainability Science, 2*(1), 133–140.

Benito, G. R., Berger, E., De la Forest, M., & Shum, J. (2003). A cluster analysis of the maritime sector in Norway. *International Journal of Transport Management, 1*(4), 203–215.

Boschma, R., Frenken, K., Bathelt, H., Feldman, M., & Kogler, D. (2012). Technological relatedness and regional branching. *Beyondterritory. Dynamicgeographies of knowledge creation, diffusion and innovation* (pp. 64–81). London: Routledge.

Burtis, P., Epstein, R., & Hwang, R. (2004). *Creating the California cleantechcluster*. Environmental Entrepreneurs and Natural Resources Defense Council. Accessed June 10, 2017, from https://www.nrdc.org/sites/default/files/cleantech.pdf

Cluster, C. C. (2012). *The global cleantech report 2012*. Copenhagen: Copenhagen Cleantech Cluster.

Costea-Dunarintu, A. (2016). The circular economy in the European Union. *Knowledge Horizons. Economics*, *8*(1): 148–150.

Davies, A. R. (2013). Cleantech clusters: Transformational assemblages for a just, green economy or just business as usual? *Global Environmental Change, 23*(5), 1285–1295.

Di Fonzo, M. & Hime, S. (2017). *How businesses measure their impacts on nature: A gap analysis* (Working Paper 01/2017). University of Cambridge Institute for Sustainability Leadership (CISL).

Dögl, C., Holtbrügge, D., & Schuster, T. (2012). Competitive advantage of German renewable energy firms in India and China: An empirical study based on Porter's diamond. *International Journal of Emerging Markets, 7*(2), 191–214.

Energy Management and Energy Savings (EMES). (2017). *Draft Business Plan ISO TC 301*. Accessed June 6, 2017, from http://isotc.iso.org/livelink/livelink/open/tc301

European Academic Science Advisory Board (EASAB). (2015). *Circular economy: A commentary from the perspectives of the natural and social sciences*. Accessed May 31, 2017, from http://vatt.fi/documents/2956369/3244616/European+Academies+Science+Advisory+Council+Circular+economy+a+commentary+from+the+perspectives+of+the+natural+and+social+sciences/82982e56-56f6-466d-8fe6-dc2b8079cb7b

European Environment Agency. (2016). *Circular economy in Europe. Developing the knowledge base* (EEA Report No. 2/2016).

Finland, C. (2014). *About Cleantech Finland*. Accessed June 10, 2017, from http://www.rohevik.ee/2012/wp-content/uploads/2012/08/Lauri_Hietaniemi_191012.pdf

Genovese, A., Acquaye, A. A., Figueroa, A., & Koh, S. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. *Omega, 66*, 344–357.

Henriksen, K., Bjerre, M., Øster, J., & Henriksen, T. (2012). *Green business model innovation-policy report*. Nordic Council of Ministers.
IWA. (2016). *Water utility pathways in a circular economy*. London: International Water Association.
Lam, H. L., Varbanov, P. S., & Klemeš, J. J. (2011). Regional renewable energy and resource planning. *Applied Energy, 88*(2), 545–550.
Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in the context of manufacturing industry. *Journal of Cleaner Production, 115*, 36–51.
MacArthur, E. & MackKinsey & Company. (2014). *World economic forum*. Accessed May 28, 2017, from http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf
Matti, C., de Vicente López, J., Sargeantson, E., Burn, C., & Dahl, P. L. S. (2016, June). *Practice-based knowledge on system innovation and climate change. A learning approach for practitioners through active-blended format*. https://www.ris.uu.nl/ws/files/22582552/WEB040716_POSTER_EDUCATION_A1.pdfv
Maxoulis, C. N., Charalampous, H. P., & Kalogirou, S. A. (2007). Cyprus solar water heating cluster: A missed opportunity? *Energy Policy, 35*(6), 3302–3315.
McCauley, S. M., & Stephens, J. C. (2012). Green energy clusters and socio-technical transitions: Analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. *Sustainability Science, 7*(2), 213–225.
Monteiro, P., de Noronha, T., & Neto, P. (2013). A differentiation framework for maritime clusters: Comparisons across Europe. *Sustainability, 5*(9), 4076–4105.
Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences*, *107*(51): 22026–22031.
Nooteboom, B., Van Haverbeke, W., Duysters, G., Gilsing, V., & Van den Oord, A. (2007). Optimal cognitive distance and absorptive capacity. *Research Policy, 36*(7), 1016–1034.
OECD. (2016). *OECD factbooks 2015-2016: Economic, environmental and social statistics*. Paris: OECD Publishing.
Oh, D. S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation, 54*, 1–6.
Partidario, M. R., & Gomes, R. C. (2013). Ecosystem services inclusive strategic environmental assessment. *Environmental Impact Assessment Review, 40*, 36–46.
Pego, A., Marques, M., Salvador, R., Soares, G., Monteiro, A. (2016). The potential offshore energy cluster in Portugal. In C. Guedes Soares (Eds.), *Progress in renewable energy offshore* (pp. 867–873). London: Taylor & Francis.
Porter, M. E. (1990). New global strategies for competitive advantage. *Planning Review, 18*(3), 4–14.
Su, B., Heshmati, A., Geng, Y., & Yu, X. (2013). A review of the circular economy in China: Moving from rhetoric to implementation. *Journal of Cleaner Production, 42*, 215–227.
Titze, M., Brachert, M., & Kubis, A. (2011). The identification of regional industrial clusters using qualitative input–output analysis (QIOA). *Regional Studies, 4*(1), 89–102.
Van der Panne, G. (2004). Agglomeration externalities: Marshall versus Jacobs. *Journal of Evolutionary Economics, 14*, 593–604.
Wijnolst, N. (2006). *Dynamic European maritime clusters* (Vol. 30). Amsterdam: IOS Press.
Zhang, F., & Cooke, P. (2009). *Global and regional development of renewable energy*. Project "Green innovation and entrepreneurship in Europe" funded EU FP6
Zhao, Z. Y., Zhang, S. Y., & Zuo, J. (2011). A critical analysis of the photovoltaic power industry in China—From diamond model to gear model. *Renewable and Sustainable Energy Reviews*, *15* (9): 4963–4971.