Green Transition and Industrial Ecosystems: the Impact of EU Taxonomy for Sustainable Activities

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Abstract

In this paper, we review the literature on industrial ecosystems and EU Taxonomy of sustainable activities. We then measure the size, dynamics and specialisation of the industrial ecosystems in Italy - as defined by the European Commission. Subsequently, we try to assess how much different sectors will be involved in the Taxonomy of sustainable activities: Manufacturing, Transportation, Electricity and Water Supply are those strongly involved in terms of employees.

EU Taxonomy will radically change in the near future the financial reporting requirements and strategic management actions in the corporate system towards green transition. Firms need to improve their level of knowledge of the Taxonomy and identify suitable actions in order to align with it.

Keywords: Industrial Ecosystem; Sustainable Activities; EU Taxonomy; Corporate Strategies; Global Competition

1. Industrial Ecosystems and Sustainable Activities

The paper analyses the role of Industrial Ecosystems and productive sectors in Italy and the possible connections with the Taxonomy of sustainable activities introduced by the European Union in 2020 (European Union, 2020). After the first paragraph, which presents a brief literature review on the two topics, in the second section an attempt is made to apply the new methodology adopted by the European Union to define and measure Industrial Ecosystems in the new perspective of sectoral interconnections and production chains (European Commission, 2021a; Turci et al., 2023). These new classifications revolutionize the traditional statistical metrics for measuring the weight of the productive sectors, on the one hand in order to highlight the upstream and downstream relationships that characterize contemporary industrial relations, on the other hand also to highlight the new "industries" in the age of knowledge and immaterial production, such as the cultural and creative goods sector

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or the personal services sector and the so-called social and proximity economy. This new definition of Industrial Ecosystems is also linked to the regional choices of the Smart Specialisation Strategy, which present platforms or production chains considered strategic in the various European regions. We therefore try to verify the size of the Industrial Ecosystems in Italy.

Finally, in the third paragraph we try to evaluate the impact of the Taxonomy of sustainable activities introduced by the European Union on the productive sectors, with respect to the first environmental objective of Climate Change Mitigation and in the preliminary codification version suggested by the Technical Expert Group (TEG) (European Commission, 2021a). From now onwards we will call "Taxonomy" the following: Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088. We are aware that the evolution of the Taxonomy rules has been constantly evolving in recent years, so the proposed elaborations represent only a first exercise to dimension the phenomenon at a regional level.

2. Theoretical and Empirical Background

Long before being formally defined by the EU Commission, industrial ecosystems have been investigated both theoretically and empirically. This kind of scientific literature has long-standing roots: it is indeed linked both to industrial economics studies – which focus on value chains – and on ecological studies of production systems. On top of the economics element, these studies also focus on social and environmental aspects. In the first part of this section some worthy contributions in this field are presented. In the second one, the first theoretical and empirical academic works on the EU taxonomy for sustainable activities are presented.

Tsujimoto et al. (2018) review the concept of *ecosystem*, particularly in the field of the management of technology and innovation. They find four major research streams: industrial ecology, business ecosystem, platform management and multi-actor network. The first research stream is based on the concept of *industrial ecosystem*, which was introduced by Frosch & Gallopoulos (1989).

> □ *the traditional model of industrial activity [...] should be transformed into a more integrated model: an industrial ecosystem. In such a system the consumption of energy and materials is optimized, waste generation is minimized and the effluents of one process [...] serve as the raw material for another process (Frosch & Gallopoulos, 1989, p. 144)*

Thirty-four years ago, the authors called for the development of more sustainable industrial ecosystems, in a setting of decreasing supplies of raw materials and increasing problems of waste and pollution.

From this concept, the term *industrial ecology* evolved: Graedel and Allenby (2010) define it as "…the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural and technological evolution. The concept requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a system view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to product, to waste product, and to ultimate disposal. Factors to be optimized include resources, energy and capital.''

Research in industrial ecosystems is gaining ground. Fan et al. (2017) for instance propose a new interactive method to construct an industrial ecosystem. Their research is in the field of eco-industry, which aims to reduce the environmental impact of the production process by the design of industrial systems (Lowe & Evans, 1995). The goal is to turn the particular system into a closed one, with the entire material and energy cycle inside the system (Côté & Cohen-Rosenthal, 1998).

Susur et al. (2019) investigate the effect of *industrial symbiosis* initiatives on the emergence of regional industrial ecosystems. Industrial symbiosis aims at closing the industrial production loops in order to make production routines circular (Sterr & Ott, 2004; Chertow, 2007; Neves et al., 2019). It aims at replicating the principles of natural ecosystems in industrial ones (McManus & Gibbs, 2008; Rizzi & Danesi, 2021).

Shi & Li (2019) propose a symbiosis-based life cycle management approach to achieve a sustainable resource flow in industrial ecosystems: this model allows to turn linear flows to circular flows and it can help decision makers to identify problems at each life cycle stage and make targeted strategies. The authors also verify the effectiveness of their approach in

improving the sustainable use of resources through a case study of the pulp and paper industrial ecosystem in Wuhan, China.

Parida et al. (2019) propose a model that aims to describe the process of ecosystem transformation. In the view of the authors, single companies cannot achieve by themselves the transition to a circular economy and an ecosystem-wide orchestration is thus necessary. Through a qualitative analysis of six large manufacturing companies (orchestrators), it is found that the transition is achieved in two stages: firstly, a comprehensive ecosystem readiness assessment is needed, in order to define the aspirations for the circular ecosystem paradigm; secondly, the ecosystem transformation conducted by orchestrators should be oriented towards different types of ecosystem partners (core, peripheral and potential) with different approaches (standardization, nurturing and negotiation).

Other recent studies include Babkin et al. (2021), who have designed and tested a methodology to assess the maturity level of an industrial ecosystem by principal component analysis and hierarchical agglomerative clustering and Burström et al. (2021), who have developed a model of industrial ecosystem transformation based on artificial intelligence.

□ *Lucarelli et al. (2020) were the first to use the EU taxonomy in the context of scientific literature: they performed a bibliometric analysis for the period 1990-2020 on the EU taxonomy environmental objectives and its macro-sectors. They found a prevalence of papers related to business innovation - especially on process improvements - and they confirmed the negative association between the level of scientific production in EU taxonomy-related areas and the level of carbon emissions. This association leads the authors to argue that innovations that come from research do have an impact of the environment.*

Ingre & Passburg (2020) explored the impact of the EU taxonomy on actively managed sustainable funds in the Swedish market by comparing it to existing systems and performing qualitative semi-structured interviews on fund managers. The authors find that, compared with existing systems for sustainability information (e.g.: the Nordis Swan Ecolabel, Morningstar Sustainability Rating, Morningstar CO2 Risk…), the EU taxonomy has a prominent focus on the Environmental dimension of ESG and it therefore potentially reduces the definition of "sustainability". Moreover, Ingre & Passburg find that the EU taxonomy does have a potential of affecting the strategies of the sustainable funds in the Swedish market, provided that third-party companies provide extensive EU taxonomy data and fund companies' investors find a good EU Taxonomy alignment important and desirable.

Och (2020) points out some potential downsides of the EU taxonomy: the high amount of ESG related disclosures it needs to function and the comparatively low requirements on the Social and Governance aspects of sustainability. The author foresees the following risk: she argues that EU taxonomy could miss its target if it ends up not being applied to the extent the legislators hope for. If only few companies and investors participate in a very small and highly regulated green market, the goal to redirect billions of Euros towards sustainable activities will not be met. The author therefore suggests to extend the current taxonomy to include a "yellow" and a "red" category, making taxonomy regulation compulsory for almost every actor.

Schütze & Stede (2021) analyse a large-scale public consultation of stakeholders about EU taxonomy, which allows them to identify some areas that might need further development. First, under the European Non-Financial Reporting Directive (NFRD, 2014/95/EU), all companies with more than 500 employees have to report non-financial information. With Corporate Sustainability Reporting Directive (CSRD, 2022/2464/EU), taxonomy-related information has been added to previous NFRD requirements. This implies that some smaller emission-intensive companies are excluded, and some other big low-emission companies are included. The authors suggest that an additional metric based purely on emission intensity should be added. Second, the taxonomy does not indicate a path towards climate neutrality for several "transition" economic activities (e.g.: building renovations or the basic materials sector like steel or cement): the taxonomy thresholds are based on current best available technology, but instead capital-intensive breakthrough technologies are needed to decarbonise these activities and they are not incentivised by the current taxonomy regulation. Third, the same technical criteria are used both for existing activities and for new investments, but this creates the risk that the taxonomy will only incentivise marginal improvements for new investments and could potentially create a lock-in into carbon-intensive assets while hindering innovation (Mattauch et al., 2015). One proposed solution is to define multiple thresholds, differentiating

between investments in new projects and in existing assets. Fourth, some economic activities are not covered by the taxonomy: some of them account for a large percentage of value added and employees, but their emissions are low; other activities are carbon-intensive but they cannot be substituted (e.g.: aviation); finally, some activities have high emissions but they can be substituted (e.g.: coal and oil). For the second group, the authors suggest to develop new thresholds; for the third group they propose to develop a "brown taxonomy" in order to exclude investments into unsustainable activities.

Alessi et al. (2021) estimated that at the time of writing the share of investments financing economic activities aligned with the taxonomy was only 1.3% (€290 billion). The sectors attracting the largest share of "green" investments were electricity production, construction and water supply, sewerage & waste management. The authors also estimated that the percentage of taxonomy-eligible outstanding securities (i.e.: related to activities covered by the taxonomy but that should meet the requirements to be considered green) were 15.1%. A third interesting estimate is the share of financing to activities that should be abandoned in the transition (e.g.: fossil fuels): 5.5%.

Köppl-Turyna & Schwarzbauer (2022) argue that the EU taxonomy will alter trade patterns and trade specialisation of European economies and this could have several consequences. First, it could result in reallocation of work and to short-term frictions and increased unemployment; second, it could worsen the trade balance of EU and of single countries and create new geopolitical dependencies; third, it could result in "carbon leakage": "brown" sector activities could move out of the EU (Aichele & Felbermayr, 2015).

Norang et al. (2023) examine how the EU taxonomy can affect the Norwegian construction industry through document analysis and in-depth interviews to different stakeholders. They find that among stakeholders there are high levels of uncertainty and concerns related to the collection of the necessary documentation: some companies might choose to wait until they have a clearer understanding but this could cause them to fall behind and lose capital and competitiveness. Another relevant issue raised by the staekholders has to do with the binary setup of the taxonomy: as opposed to other schemes related to sustainability, the EU taxonomy is not a scale, but a binary evaluation: in or out. This could cause the taxonomy to be less attractive, as activities doing well but not enough to be considered "green" will be penalised just as activities that are far away from meeting the taxonomy requirements.

Lucarelli et al. (2023) investigate whether the introduction of EU Taxonomy regulations had an impact on corporate investments for Taxonomy-eligible companies as compared to non-eligible ones. The authors specify a diff-in-diff econometric model using a sample of more than 130,000 firms from 27 EU Member States. They find that being in an eligible sector as specified by the EU Taxonomy did not have, by itself, an effect on the increase of corporate investments. When firms' eligible sector is defined at the level of NACE 4 digits, instead, the model finds a significant increase in investments, as companies face lower uncertainty and decide to invest more. Also, the authors find that firm size plays a role: given the same level of Taxonomy-eligibility uncertainty (i.e. how many NACE digits specify the firm's eligible sector), medium and large companies increased investments more than small ones. This study provides useful preliminary insights, but it also has some limitations: first, the observation period is limited to the years 2015-2019 and the impact of Taxonomy eligibility on the increase of investments is measured only as pre-2019 level vs. 2019 level, but EU Taxonomy first regulations were only issued in mid-2019 and the first delegated act was published in December 2021, so the authors strong hypothesis is that Taxonomy-eligible companies reacted early, before the acts were issued. Secondly, the dependent variable of the model is the annual variation of fixed assets, derived from firm-level data[1] and it does not measure specifically green investments, because of a lack of data on this issue.

3. Industrial Ecosystems in Europe and in Italy

Industrial ecosystems were defined in the March 2020 Industrial Strategy by the European Commission (European Commission, 2020) in order to better cope with the COVID-19 pandemic. They highlight the interconnections between different economic actors, both vertically and horizontally. Ancillary activities, such as research & innovation, access to distribution networks, business services or the supply of raw materials, are integrated to the core industry sectors (European Commission, 2021).

A total of 14 ecosystems were identified, based on their technological and economic relevance, and for their expected contribution to the decarbonisation, digitalisation and resilience of the EU economy: Aerospace and Defence, Agri-food, Construction, Cultural and Creative Industries, Digital, Electronics, Energy Intensive Industries, Energy-Renewables, Health, Mobility-Transport-Automotive, Proximity, Social Economy and Civil Security, Retail, Textiles, and Tourism. They account for approximately 70% of the EU economy and 80% of the business economy as a share of value added (European Commission, 2021).

Ecosystems are interlinked (e.g., the Retail ecosystem provides services to all other ecosystems) and they also overlap with each other, as some activities are relevant for more than one ecosystem (e.g.: professional services, waste management…). The NACE rev.2 (2-digits) classification has been used to define the 14 ecosystems, which are composed of core activities and of "horizontal" activities (that are weighted based on their specific contribution to the core activities of each ecosystem).

By using industrial ecosystem as defined by the European Commission, it is possible to weight how many employed people work in each ecosystem in Italy and in Europe (Table 1).

In absolute terms, the ecosystems that employ the most people in Italy are Retail, Construction and Tourism. The location quotients (i.e., ratios that measure the concentration of an ecosystem in Italy relatively to the concentration of that ecosystem in Europe) are highest for Textile (2,26), Tourism (1,17) and Proximity, Social Economy and Civil Security (1,04).

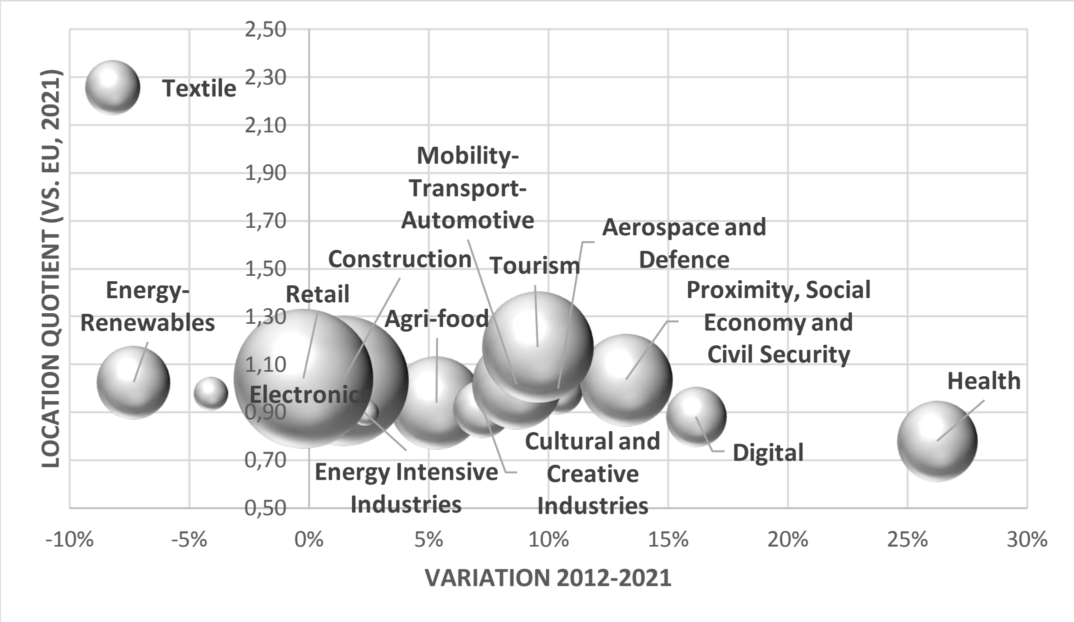
Table 1: *EU Industrial Ecosystems in Europe and in Italy (employees and location quotients 2021)*

EU Industrial Ecosystem	Employees (Italy)	Employees (Europe)	%*	LQ vs. Europe[q]
Aerospace & Defence	475.363	4.319.543	2,61	1,00
Agri-Food	1.604.586	15.494.141	8,82	0,94
Construction	3.009.878	26.425.631	16,55	1,03
Cultural And Creative	617.434	6.119.490	3,40	0,92
Digital	726.893	7.486.566	4,00	0,88
Electronics	186.828	1.732.100	1,03	0,98
Energy Renewables	868.227	7.686.788	4,77	1,02
Energy Intensive Industries	123.539	1.245.455	0,68	0,90
Health	1.420.666	16.533.050	7,81	0,78
Mobility Transport Automotive	1.525.125	13.597.613	8,39	1,02
Proximity, Social Economy…	1.705.596	14.942.934	9,38	1,04
Retail	3.416.774	29.756.038	18,79	1,04
Textile	477.794	1.919.264	2,63	2,26
Tourism	2.388.569	18.479.249	13,14	1,17

* percentage of employees on total employed people (not only in industrial ecosystems)
[q] ratio between percentage weight of the ecosystem in Italy and in Europe
Source: ISTAT

Figure 1 plots all 14 ecosystems in Italy in terms of variation of employees (x-axis), location quotients (y-axis) and dimension of employees (bubble size): the ecosystems that grew the most from 2012 to 2021 have been Health (+26,2%), Digital (+16,2%) and Proximity, Social Economy and Civil Security (+13,2%) while those that shrunk the most have Textile (-8,2%), Energy-Renewables (-7,3%) and Electronics (-4,1%).

Figure 1: *Industrial Ecosystems in Italy: Size, LQ, Variation 2012-2021*



4. Ecological Transition and Taxonomy of Sustainable Activities

The path that leads the regional economic systems towards sustainable development has been driven both by theoretical reflections and by important institutional policies at the international and national level. From the first studies on the Club of Rome "Limits to growth" (Meadows et al., 1972) to the new approaches on sustainable competitiveness and resilience in the three spheres of sustainability (Graziano & Rizzi, 2016; Rizzi et al., 2018; Graziano et al., 2019; Cantoni et al., 2019) in the field of theoretical reflection; from the Brundtland Commission (World Commission on Environment and Development, 1987) up to the UN Agenda 2030 on the institutional front (United Nations, 2015) and on the international landscape (Brondoni & Musso, 2023).

The European Green Deal has set a challenging target for the EU: to become climate-neutral by 2050. One of the targeted strategies established to reach this goal is the EU Taxonomy for sustainable activities (European Commission, 2019).The EU taxonomy is a classification system whose aim is to “*establish the criteria for determining whether an economic activity qualifies as environmentally sustainable for the purpose of establishing the degree to which an investment is environmentally sustainable*” (European Union, 2020).

□ *The Taxonomy regulation establishes the following six environmental objectives:*

1. *Climate change mitigation*
2. *Climate change adaptation*
3. *The sustainable use and protection of water*
4. *The transition to a circular economy*
5. *Pollution prevention and control*

The protection and restoration of biodiversity and ecosystems

Any economic activity is qualified as environmentally sustainable if it satisfies these 4 requirements: it contributes substantially to one or more of the six environmental objectives; it does not significantly harm (DNSH) any of the six environmental objectives; it is carried out in compliance with minimum social safeguards; it complies with specific technical screening criteria (TSC).

It was published on 22 June 2020 and it entered into force on 12 July 2020. In order to be supported technically in its work on the EU Taxonomy, the European Commission had established a Technical Expert Group (TEG) in July 2018: on 9 March 2020 the TEG published its final report: it contains recommendations on the design of the EU Taxonomy and guidance on how companies and financial institutions can use and disclose against the EU taxonomy (Slevin et al., 2020).

The specific TSC for the first 2 environmental objectives have been defined by the first delegated act, called "Climate Delegated Act which was published on 9th December 2021 and it is applicable since January 2022 (European Commission, 2021b). On 21st November 2023, the Environmental Delegated Act was published in the Official Journal of the European Union: it defines the TSC for the remaining 4 environmental objectives and it is applicable since January 2024. On the same date another Delegated Regulation amending the Climate Delegated Act was published.

There are three types of activities that substantially contribute to one of the six environmental objectives:

- "own performance": activities that by themselves are performed in a way that substantially contributes to an environmental objective (e.g.: energy efficient manufacturing processes);
- "enabling": activities that improve the performance of another economic activity while observing the DNSH criteria (e.g.: manufacture of low carbon products);
- "transitional": activities for which there is no feasible low-carbon alternative, but that satisfy additional criteria (among other, it has best-in-class greenhouse gas emission levels).

In March 2020, the Technical Expert Group released a document called "Taxonomy tools", which precisely identified the subsectors involved in the first environmental objective: climate change mitigation. Using those NACE codes, it is possible to evaluate how many employees in every sector might be involved in the EU Taxonomy. More recently an EU Taxonomy Navigator has been provided that includes an EU Taxonomy Calculator in order to support companies in their reporting obligations. A "simplified reading" of the EU Taxonomy, with a first assessment of its implication has been proposed by Bicocca University (OFIRE, 2022).

In Table 2 and following tables, the number of employees in these sub-sectors is presented, both in Italy and in Europe, following the first analysis by CERVED (2020). The data are relative to the year 2021.

In the manufacturing sector, 49,5% of employees work in activities involved in the first environmental objective (in Europe, 48,1%) (Table 2).

Table 2: *Persons Employed in Sectors Involved in the Climate Mitigation Objective – Manufacturing Sector*

NACE	Activity	EU27	Italy
C1623	Manufacture of other builders' carpentry and joinery[E]	376.000	48.767
C2011	Manufacture of industrial gases[O]	36.788	4.316
C2013	Manufacture of other inorganic basic chemicals[T]	N/A	4.864
C2014	Manufacture of other organic basic chemicals[T]	207.733	8.096
C2015	Manufacture of fertilisers and nitrogen compounds[OT]	N/A	3.190
C2016	Manufacture of plastics in primary forms[T]	139.557	13.466
C22	Manufacture of rubber and plastic products[E]	1.700.000	185.311
C2311	Manufacture of flat glass[E]	22.100	2.587
C2320	Manufacture of refractory products[E]	24.800	1.950
C2331	Manufacture of ceramic tiles and flags[E]	60.860	18.930
C2332	Manufacture of bricks, tiles and construction products[E]	44.679	3.205
C2343	Manufacture of ceramic insulators and insulating fittings[E]	4.180	72
C2351	Manufacture of cement[T]	58.293	4.389
C2361	Manufacture of concrete products for construction purposes[E]	208.000	12.227
C2410	Manufacture of basic iron and steel and of ferro-alloys[T]	315.344	37.956
C2420	Manufacture of tubes, pipes[T]	95.090	14.979
C2431	Cold drawing of bars[T]	4.690	235
C2432	Cold rolling of narrow strip[T]	11.000	1.922
C2433	Cold forming or folding[T]	32.475	7.687
C2434	Cold drawing of wire[T]	23.733	5.758
C2442	Aluminium production[T]	119.099	11.833
C2451	Casting of iron[T]	71.000	7.006
C2452	Casting of steel[T]	23.952	2.280
C2453	Casting of light metals[T]	87.200	10.401
C25	Manuf. of fabricated metal products, except machinery[E]	3.662.128	585.308
C26	Manufacture of computer, electronic and optical products[E]	1.060.000	96.672
C27	Manufacture of electrical equipment[E]	1.507.497	149.214
C28	Manufacture of machinery and equipment n.e.c. [E]	2.989.926	471.075
C291	Manufacture of motor vehicles[E]	1.100.000	62.072
C301	Building of ships and boats[E]	N/A	30.963
C302	Manufacture of railway locomotives and rolling stock[E]	111.736	10.954
C309	Manufacture of transport equipment n.e.c. [E]	68.679	16.653

C3315	Repair and maintenance of ships and boats[E]	94.000	11.843
C3317	Repair and maintenance of other transport equipment[E]	50.791	4.387
E3832	Recovery of sorted materials[E]	196.131	33.805
C	Manufacturing (*Total*)	29.719.650	3.741.072
C	Manufacturing (*Taxonomy-eligible*)	14.311.330	1.850.568
	% of people employed in the manufacturing sector who are involved in taxonomy-eligible activities	**48,1%**	**49,5%**

[O] "Own performance" activity; [E] Enabling activity; [T] Transitional Activity

In the electricity sector, 77,4% of employed people in Italy work in activities that could potentially contribute to climate change mitigation (Table 3).

The transportation and logistics sector involve many of their employees, both in Italy (69,7%) and in Europe (76,4%).

The water supply, sewerage and waste management sector will be central in climate change mitigation: 94,42% of people employed in this sector work in potentially mitigating activities in Italy (96,15% in EU27). This result is coherent with the study by Laboratorio REF Ricerche (2023), that found that at the national level, more than 90% of the Water supply sector is taxonomy-eligible.

Table 3: *Persons Employed in Sectors Involved in the Climate Mitigation Objective Electricity Sector*

NACE	Activity	EU27	Italy
D3511	Production of electricity[OT]	N/A	27.015
D3512	Transmission of electricity[E]	67.051	4.042
D3513	Distribution of electricity[E]	246.687	17.880
D3521	Manufacture of gas[O]	11.800	316
D3522	Distribution of gaseous fuels through mains[O]	N/A	10.942
D3530	Steam and air conditioning supply[OT]	N/A	2.967
F4221	Construction of utility projects for fluids[O]	200.000	8.902
F4222	Construction of utility projects for electricity and telecom.[OT]	250.000	15.558
F4322	Plumbing, heat and air-conditioning installation[O]	1.478.944	195.147
H4950	Transport via pipeline[O]	27.300	2.606
M72	Scientific research and development[T]	504.000	37.969
D	Electricity, gas, steam and air conditioning supply (*Total*)	1.340.000	81.572
D	Electricity, gas, steam and air conditioning supply (*Taxonomy-eligible*)	325.538	63.162
	% of employees in the electricity, gas, steam and air conditioning sector who are involved in taxonomy-eligible activities	**24,3%**	**77,4%**

[O] "Own performance" activity; [E] Enabling activity; [T] Transitional Activity

Table 4: *Employees Working in Sectors Involved in the Climate Mitigation Objective – Transportation Sector*

NACE	Activity	EU27	Italy
C3315	Repair and maintenance of ships and boats[T]	94.000	11.843
F4120	Construction of residential and non-residential buildings[E]	3.004.403	320.434
F4211	Construction of roads and motorways[E]	725.732	40.852
F4212	Construction of railways and underground railways[E]	88.578	7.804
F4213	Construction of bridges and tunnels[E]	54.999	2.055
F4291	Construction of water projects[E]	64.873	7.094
F4299	Construction of other civil engineering projects n.e.c. [E]	183.000	14.921
F4321	Electrical installation[E]	1.661.343	243.009
H4910	Passenger rail transport, interurban[T]	425.812	31.527
H4920	Freight rail transport[T]	119.926	5.144
H4931	Urban and suburban passenger land transport[T]	670.413	79.326
H4932	Taxi operation[T]	584.587	37.485
H4939	Other passenger land transport n.e.c. [T]	428.318	39.089
H4941	Freight transport by road[T]	3.338.870	365.256
H5010	Sea and coastal passenger water transport[T]	73.128	28.540
H502	Sea and coastal freight water transport[T]	72.000	8.177
H5030	Inland passenger water transport[T]	18.412	2.375
H504	Inland freight water transport[T]	N/A	612
H5221	Service activities incidental to land transportation[E]	319.945	47.467
H5222	Service activities incidental to water transportation[T]	101.000	15.137
H5310	Postal activities under universal service obligation[T]	728.000	115.215
H5320	Other postal and courier activities[T]	903.221	22.088
M711	Architectural and engineering activities[E]	2.588.445	281.247
M7120	Technical testing and analysis[E]	483.914	42.179
N7711	Renting and leasing of cars and light motor vehicles[OT]	157.973	13.113
N7712	Renting and leasing of trucks[ET]	23.800	1.236
N7721	Renting and leasing of recreational and sports goods[OT]	33.837	4.953
N7734	Renting and leasing of water transport equipment[T]	14.500	775
N7739	Rent. and leas. of other machinery[T]	138.560	17.073
H	Transportation and storage (*Total*)	10.182.339	1.144.856
H	Transportation and storage (*Taxonomy-eligible*)	7.783.632	797.440
	% of employees in the transportation and storage sector who are involved in taxonomy-eligible activities	**76,4%**	**69,7%**

[O] "Own performance" activity; [E] Enabling activity; [T] Transitional Activity

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4. Conclusion

This paper applies the new methodology for defining industrial ecosystems as introduced by the European Union to Italy.

This redefinition of production sectors responds to the need to highlight the inter-sectoral connections and supply chain links, which have always characterised the secondary sector, but which have turned – in the contemporary economy – into accentuated processes of servitisation and fragmentation of production structures, at the physical, productive and geographical level.

In the same direction, regional Smart Specialisation strategies identify the production systems considered strategic for the sustainable and competitive development of territories. The intention of the European legislator and of regional administrations is to identify the specific vocations of each territory, according to bottom-up approaches aimed at reinforcing the strengths of the industrial apparatuses and at fostering the development of the most technologically and environmentally innovative sectors. We have found a fair degree of consistency between the new classifications of EU industrial ecosystems and the Smart Specialisation systems of some regions, such as Lombardy and Emilia-Romagna. The paper's objective is eminently definitional and descriptive and it also aims to inspect the production sectors involved in the Taxonomy for Sustainable Activities as introduced by the European Union.

With respect to the first environmental objective of Mitigation, it emerges that the sectors of Manufacturing, Electricity, Transportation and Water supply, sewerage and waste management are strongly involved in the Taxonomy, even if we must emphasise that the actual alignment to the Taxonomy depends on the specific Technical Screening Criteria. In fact, the actual complying to the Taxonomy of the single firms will depend on the specific company strategies adopted and on the accompanying policies on the national and regional scale. In future studies and surveys, we will try to verify both the level of knowledge of the taxonomy among companies and the actions already undertaken or planned at the level of industrial ecosystems.

The aim will be to identify the factors that stimulate a more rapid ecological transition in the productive systems and the necessary accompanying policies.

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Notes

[1] Amadeus, by Bureau Van Dijk