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THE ROLE OF CIRCULAR CUMULATIVE CAUSATION AND ECONOMIC GEOGRAPHY APPROACH IN THE DEVELOPMENT OF NEW INDUSTRIES: EXAMPLE OF GREEN HYDROGEN INDUSTRY EVOLUTION IN LATVIA AND ESTONIA

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Abstract. The unbalanced development of regions within the European Union (EU) faces challenges for sustainable economic growth opportunities in the future. Uneven scattering of industrial capacities across the EU determines the unequal distribution of wealth among the member states. The EU economy's Green Deal strategy determines the necessity of developing new technologies in both existing industries and developing new ones.

The research emphasises two theories concerning territorial development issues. Circular cumulative causation theory and economic geography distinguish the development of industry, especially the manufacturing sector, as a crucial aspect of the economic development of a particular area. The symbiosis of both theories provides guidelines for a balanced approach to territory economic development capabilities in light of industry sustainability requirements in the present-day economy. The purpose of the study is to evaluate the combined circular cumulative causation and economic geography theory analysis approach by comparing the potential for the development of the green hydrogen industry in Latvia and Estonia. Hydrogen is one of the most likely energy sources to replace fossil fuels in the coming decades, and it possesses high potential for transportation, manufacturing, energy supply, and other sectors of the economy.

The study established the research pattern within theoretical bases and identified general trends concerning an assessment framework, which can lead to unbalanced values in the industry's potential evaluation process. The findings of the evaluation of the green hydrogen industry indicate Estonia's slight advantage over Latvia.

Key words: economic geography, regional economics, industry development, green hydrogen, industry linkages.

JEL code: R00

Introduction

Unbalanced industry capacity across the Latvian regions is leading to an uneven distribution of wealth among the population in different parts of the country. The Green Deal approach in the EU economy determines the necessity for the evolution of new techniques in existing industries and the development of new industries. It offers an opportunity for the EU countries to employ a new economic paradigm for more balanced regional development. Along these lines, an appropriate theoretical background for the new initiatives in industry development must be identified and tested.

The hypothesis of the study suggests that circular cumulative causation theory and an economic geography approach can provide a fitting analytical framework for the development of new industries in a particular territory. The object of the study is the unified circular cumulative causation and economic geography theoretical framework in the industry evolution process. The subject of this research is a study approach for a particular industry's potential assessment within the selected theoretical frame.

The aim of the research is to evaluate the unified circular cumulative causation and economic geography theory analysis approach by comparing green hydrogen industry development possibilities in Latvia and Estonia. The specified aim is accompanied by the following tasks: to review the scientific literature on circular cumulative causation and economic geography theory; to describe the new approach for new industry development assessment; to compare the acquired results from established techniques regarding Latvia and Estonia in the light of green hydrogen industry development; and to evaluate the durability and applicability of the assessment framework.

For the accomplishment of the presented tasks of the study, the authors employed the monographic or descriptive study method and the modelling method. The information sources for the study consist of

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scientific publications and monographies on selected theories, industries, and regional development. Secondary data on statistical indicators concerning Latvia, Estonia, and average values of the EU economic development and industry sectors are presented and analysed.

The combination of circular cumulative causation theory and an economic geography approach for establishing an assessment framework for industry development is the new perspective for regional policy analysis. Notwithstanding, the utilisation of this economic approach can be only one of the many tools to identify industry development possibilities in a particular territory. The proposed economic technique must be examined in other wide-ranging studies on the subjects of industry and regional development.

Research results and discussion

The discussion about the study and its results is divided into two parts. The first part represents the debate concerning the theoretical framework of the research. The second part deals with the assessment technique and its results regarding green hydrogen industry analysis in Latvia and Estonia.

1. Circular cumulative causation, economic geography, regional development and industry

According to circular cumulative causation theory thinkers like Gunnar Myrdal and Nicholas Kaldor, one of the most important aspects of economic development for a particular society is the growth of the industry, which is measured by productivity gains in this sector. Growth in the manufacturing sector contributes to productivity increases in other sectors of the economy (Berger, 2009; Thirlwall, 2002). Within this perspective, the dominant role of industry in territorial development is undeniable.

A broad consensus within economic philosophy determines a set of activities and processes that contribute to industry development in a certain territory. These contributors are urbanisation, market size, industry linkages, investments, transportation costs, etc. Furthermore, the starting position between neighbouring regions regarding socioeconomic development indicators and government policy initiatives influences the economic growth perspectives of these territories (Knaap, 2004; Krugman, 1991; Myrdal, 1957).

Circular cumulative causation theory contributes to economic geography by describing a cycle of economic growth in regions with monopolistic competition. A region with a large population will be an attractive territory for production localization because of the sizeable local market and the availability of other local goods and services. This course of events will contribute to the inflow of a larger number of people from other neighbouring regions with less developed industries. This process will continue until the population is concentrated in a few of the most industrialised territories (Krugman, 1991). From this perspective, the circular cumulative causation is considered as a frame for geography-relevant economic processes, industry and territorial development.

Population concentration in one region of the country contributes to uneven development because it leads to a larger movement of labour, capital, goods, and services in this territory. Migration, capital movements and trade are channels where the cumulative process develops with a positive trend in successful regions and a negative development scenario in disadvantaged regions. When investments, purchasing power and demand are increasing in a specified region, it contributes to the attractiveness of new investments, which, through the industrialization process, leads to higher rates of purchasing power and demand, and this cycle tends to continue. Furthermore, a region without investment inflow within a specified timeframe will not be able to afford the proper maintenance of infrastructure and the provision of the necessary services of an appropriate quality to the community, which will lower the competitiveness level of this area in terms of capital attraction (Myrdal, 1957). Population concentration provides an

additional cumulative effect for economic growth since the potential market for different industries and services is increasing. According to a positive feedback perspective, manufacturing tends to condense where a large market exists, but a substantial market emerges where manufacturing production is concentrated (Krugman, 1991). The size of the population in a region increases as more job and business opportunities are created. Investment and industrial activity are major forces for developing and sustaining the centralising forces of a regional population (Nakamura, 2013). In accordance with the highlighted premises, market size is tightly linked with population concentration in certain territories.

Population concentration and market size are only part of the whole picture in regional development. Connections between firms and industries are a decisive element for further economic growth possibilities. In the economic development process, linkages among different firms in a region exist. These linkages are closely related to input-output analysis patterns. They cover the input and output processes of production concerning relations between firms. There are backward linkages when a firm needs inputs from other firms for producing processes and forward linkages when the firm produces inputs for other firms (Hirshman, 1958). If a manufacturer sells goods primarily to export markets and relies on imported inputs, then there would be less incentive to localise near a country's regional centre. Because most production output is sold abroad, there will be little backward linkage and little forward linkage since most inputs derive from abroad (Krugman, Livas, 1996). Linkages among firms and industries facilitate the evolution of territories with certain kinds of industry concentration. Investment inflows can facilitate spatially constrained external economies in a region. For instance, the high technology industry in Silicon Valley employs localization of the economy, where the closeness of related firms within the same industry empowers high and cost-effective economic activity (Nakamura, 2013). The number of linkages that new industries can provide for the local economy is another topic of interest for understanding the economic ecosystem and the possibilities of economic growth. New linkages provide additional capabilities for economic activity and lead to multiplier effects in connected firms and sectors of the economy.

Spatial agglomeration or dispersion of economic activity is closely linked to the issue of uneven regional development. Agglomeration is understood as a territory where more monopolistically competitive firms are located than in other territories. Increasing returns to scale at the firm level suggest that each firm is a lone producer of its own good variety and can choose to produce it in one region or another. Manufacturing location in one or a few territories is determined by pecuniary externalities derived from the interlinkage of increasing returns with transportation costs between regions (Meardon, 2001).

There is an obvious connection between regional development perspectives, the industrial development of territories, and economic geography. Population proportions between neighbouring regions on a large scale are determined by which region will gain population in the case of decreasing transportation costs and manufacturing development. The regions with larger initial population rates will gain population at the expense of neighbouring territories (Krugman, 1991). It is presumed that low costs of transportation for intermediate goods will be beneficial for linkages between firms and could facilitate agglomeration stability (Hirshman, 1958). The distance between manufacturing location and market has the power to define patterns of territorial development and urbanisation level in a particular territory. The genesis of manufacturing and consumption in the same territory is leading to a large urbanisation rate supported by additional manufacturing and service firms (Krugman, Livas, 1996). Samuelson's Iceberg model suggests that transportation costs are linearly connected with distance. The longer the transportation route, the more substantial value is extracted from the arriving volume of goods, and vice versa (Krugman, 1991).

Since distance from manufacturing location to market is highly relevant for the industry development of a particular territory, the transportation infrastructure and transportation costs must be examined in the

case of remote markets within a region, country, or other part of the globe. Physical distance to the market and geographical characteristics is only one way to assess the transportation costs of hypothetical industry localization. There are tools and practises for overcoming physical distance. For instance, the larger the amount of goods transported at one time, the lower the transportation costs per unit of merchandise, and the more sustainability is ensured. Furthermore, the technical complexity of transportation for a particular good or material must be rigorously considered because it generates additional expenses. As well, the capability of infrastructure for sustainable transportation of large amounts of goods or materials must be taken into account. For operation durability, a multimodal approach to the transportation chain must be ensured. Switching from one type of transport to another in cases of unpredictable disruptions or challenges is highly beneficial.

Uneven regional development is rooted not only in previously described socioeconomic assumptions but is additionally determined by timeframe perspective and industry evolution starting point. The initial advantages in industrial development and capital inflow of a certain region determine that it is more beneficial from a mutual market perspective than neighbouring territories, and this phenomenon tends to increase, contrary to the assumptions of classical economic theory (King, 2009). The major issue is not how large the population concentration or industry size in a particular region is according to the global scale, but what its position is between neighbouring regions. Regions with a larger capital stock will provide larger profits for firms. According to this assumption, regions with more developed industries will benefit on a larger scale, and economic growth will be faster than in adjacent territories (Krugman, 1981).

According to previously analysed theoretical guidelines, regions need to maximise their dedication to attract investment flows as soon as possible. A country, region, or municipality must act as an agent who promotes its territory and competes with other agents to attract investments. Furthermore, the government has an important role in territorial development issues concerning many factors of economic growth. Patterns of economic geography may be influenced by government policy and the increasing complexity of the economic growth framework (Rickard, 2020). In accordance with French economist Francis Perroux, a vision for employing government action to transform a territorial agglomeration into a growth pole exists. This pole is characterised by major industries around which linked industries evolve (Higgins, Savoie, 1988). The government must promote selected individuals and commercial units of the agglomeration that interact with multinational firms into a growth pole that provides gains for these units that were not originally intended to benefit from its activities. The government's action could be as straightforward as developing or enhancing communication and transportation infrastructure. Moreover, large companies must take part in the transformation process from growth pole to development pole (Meardon, 2001). In this theoretical perspective, individual economic agents existing in a monopolistic competition model become interconnected through the backward and forward linkages of manufacturing.

The dominance of one industry is transforming the forms of relations between economic units. These actors are starting to behave as different parts of a whole growth pole. Core industries create multiplying effects on other firms that enhance their dependent position regarding the central industry's economic success. The underpinning foundation of the development pole is industries that generate profit opportunities in other fields of the economy as they expand (Meardon, 2001). Therefore, the emergence of an industry must be the product of some prior demand. There must be tools for encouraging this demand for the purpose of further development. (Hirshman, 1958).

Territory planning and the economic development of a certain territory are closely related. Economic growth consists of a continuous system of relations between the centre and the periphery concerning their transformation due to the development and diffusion of innovations. Diffusion of innovations occurs in three

directions: from the leading economic regions to the areas of the periphery; from the higher-level centres to the lesser centres; and from the major cities to the neighbouring territories. A growth pole is an area with potential for economic development. For this purpose, the most favourable location with the most appropriate combination of resources and location is chosen, and with the establishment of infrastructure facilities and manufacturing businesses, the growth pole becomes the development centre (Friedmann, 1967). The evolution of industries contributes to the emergence of development poles and the diffusion of economic growth.

2. Framework for evaluation of green hydrogen industry development in Estonia and Latvia

Latvia and Estonia have many similar geographical, economic, political, and demographic characteristics, and the evolution of new industries is likely in both countries. To a large extent, both territories have matching transportation infrastructure and are physically close to the main markets for goods produced in other regions.

Under the EU Green Deal, member states are expected to reduce greenhouse gas emissions by 55% by 2030 compared to 1990 while achieving net zero greenhouse gas emissions by 2050. Further economic development should be based on climate-neutral energy sources (European Council, 2022).

Hydrogen retrieved from renewable energy sources, known as green hydrogen, is one of the most likely energy sources to replace fossil fuels. According to data from the International Energy Agency, the use of hydrogen in the global economy increased from 18 Mt to 94 Mt per year between 1975 and 2021 (International Energy Agency, 2019, 2022). According to World Bank estimates, by 2050, the market demand for hydrogen will be around 600 Mt per year. At present, only 5% of the hydrogen produced is processed through renewable resources (mostly wind and solar) (World Bank, 2022).

Despite high fuel prices and the EU's focus on the green economy, Latvia and Estonia are only now making the first steps towards green hydrogen industry development. The first phase pilot projects for hydrogen use in public transportation, exploring wind farm connectivity capacities with hydrogen production, and creating a framework for a hydrogen valley in Estonia and around the Baltic Sea are under way (Vesinikuorg, 2022, Invest in Estonia, 2022, Labs of Latvia, 2023). Within this framework, a broad list of actions concerning testing various hydrogen technology solutions, investigating production potential, prototyping technologies, developing fundamental infrastructure, and encouraging systematic intersectoral cooperation must be implemented.

The role of government is obvious in the advancement of the green hydrogen industry. By applying EU Green Deal strategy guidelines, state institutions provide a stronger foundation and financial motivation for nature-neutral energy use. EU-founded projects are milestones for starting hydrogen production and application in different areas of the economy. Furthermore, strategies and roadmaps for hydrogen introduction and usage are essential signs of government inclination regarding this issue.

For further analysis, according to the previous theoretical premises, a number of ingredients necessary for industry localization and development have been determined. Six elements can be identified: population concentration, investment inflow, industry linkages, transportation costs, transportation infrastructure, and particular industry evolution in the neighbouring regions.

Indicators of population concentration include changes in population over a given time period and migration data. Investment flow is expressed in foreign direct investments per capita, investments in specific industries, and rating indexes. Estimates of the length and capacity of highway, train, pipeline, airport, and port infrastructure in relation to specific industrial demands can be used to evaluate

transportation infrastructure. Transportation costs are the most volatile indicator due to particular industry transportation requirements, different freight rates, and fuel prices in a certain region. Industry linkages can be identified by industries input and output compositions and related indexes. Finally, a certain industry evolution in neighbouring regions can be conducted by analysing existing bases for new industries or associated production or service sectors of the economy and by conducting a policy agenda assessment in the particular field.

For the testing of an established industry development assessment framework, the situation in Latvia is compared to tendencies in Estonia regarding green hydrogen industry evolution potential. Within the analysis, both relatively compact countries are perceived as two neighbouring regions. For description and background knowledge, some of the six criteria values are compared to average values in the EU.

For the purpose of industry potential assessment, the approach values of established criteria are set from 1 to 2 based on their particular closeness and importance to the green hydrogen industry. Further, the difference between two regions' data is divided into five ranks with values from 1 to 3. The more successful region receives one of the difference coefficients multiplied by the criteria value. The region with inferior results in certain criteria acquires only the base value of the analysed criteria; the same path is applied when both regions have identical values in the same indicator (Table 1).

Table 1

Criteria and difference coefficient values for industry potential assessment in a certain territory

Criteria concerning the green hydrogen industry (A)	Value	Difference between regions in statistical data (B)	Value
Overall situation describing industry potential	1	No	1
Adjacent fields for industry	1.5	Minor	1.5
Directly connected fields with industry	2	Average	2
		Major	2.5
		Huge	3

Source: author's framework for the analysis of gathered data

The gathered data represents six areas of analysis with 28 criteria concerning the green hydrogen industry or describing the overall situation in certain points of interest. Data concerning average EU indicators are included in numerous sections of the table to illustrate the situation at the European level (Table 2).

Table 2

Criteria and difference coefficient values for green hydrogen industry potential assessment in Latvia and Estonia (2017-2022)

Criteria	Criteria value (A)	Latvia	Estonia	European Union	Difference coefficient (B)	Latvia (A*B)	Estonia (A*B)
People concentration							
Population 2021	1.5	1 893 223	1 330 068	16 563 240	1.5	2.25	1.50
Population dynamics 2017-2021, %	1.5	-3.0	1.1	0.4	2.5	1.50	3.75
Net migration 2017-2021, EU 2020, %	1.5	-2.0	4.3	2.5	2.5	1.50	3.75
Workforce from population 2021, %	1.5	50.4	53.0	48.5	1.5	1.50	2.25
Total						**6.75**	**11.25**
Investment							
FDI per capita average 2017-2021, USD	1.5	929	2 525	669	3	1.50	4.50
FDI per capita average by energy sector 2017-2021, USD million	1.5	19.4	2.4	*	3	4.50	1.50
Credit rating, S&P Global, Moody's, Fitch 2022	1	A-	AA-	*	1.5	1.00	1.50
Doing business rating 2020, score	1	80.3	80.6	76.1	1.5	1.00	1.50
PPP Total, National currency units/USD, 2021	1.5	0.509	0.544	0.693	2	1.50	3.00
Total						**9.50**	**12.00**
Transportation infrastructure							
Road network density, km by km^2 2020	1.5	0.9	1.4	1.8	2	1.50	3.00
Railroad density, km by 1000 km^2 2021	1.5	28.8	25.8	55.27	1.5	2.25	1.50
Logistic performance index	1	2.81	3.31	3.52	2	1.00	2.00
Gas transmission network density, km by 1000 km^2 2022	2	18.4	21.6	*	1.5	2.00	3.00
Gross weight of seaborn freight handled in ports t per capita 2021	1.5	29.6	21.1	7.7	2	3.00	1.50
Total						**9.75**	**11.00**
Transportation costs							
Transmission share in cost of natural gas 2021, %	1.5	29.0	47.0	30.7	2.5	3.75	1.50
Average diesel price in 2022, EUR	1.5	1.78	1.77	*	1.5	1.50	2.25
CPI for transportation, 2022	1	132	242	124	3	1.00	3.00
Total						**6.25**	**6.75**
Industry linkages							
Large scale mineral fertilizer production	2	0	0	*	2	2	2
Steel industry	2	0	0	*	1	2	2
Transport	2	1	2	*	1.5	2	3
Renewables share in energy balance 2021, %	2	42.1	37.6	21.8	1.5	3	2
Wind energy in electricity produced 2021, %	2	2.0	7.0	14.0	2	2	4
Economy complexity rating 2020	1	0.71	0.99	1.15	2	1	2
Global Innovation Index	1	36.5	50.2	45.6	2.5	1	2.5
R&D from GDP 2020, %	1	0.71	1.79	2.32	2.5	1	2.5
Level of productivity 2021, USD constant prices	1	41.4	42.9	55.3	1.5	1	1.5
Total						**15.0**	**21.5**
Hydrogen industry evolution							
Policy roadmap	2	0	0	*	1	2	2
Large and midsize projects on low-carbon hydrogen	2	1	2	*	1.5	1	3
Total						**3**	**5**

Source: author's calculations based on gathered data

Conducted analysis regarding green hydrogen industry development opportunities indicates Estonia has a significant overall lead over Latvia. From the 28 criteria used in the assessment, Estonia has a higher score in 19 of them. Latvia has a higher rating in six criteria, but in three criteria, the neighbouring countries have an equal score. The major gap between these two regions is determined by population concentration criteria and industry linkage indicators.

Nine of the 19 criteria representing the average values concerning the EU are greater than in Estonia and Latvia. The major difference applies to people's concentration, road and railroad transport density, the complexity of the economy, and productivity. Though there isn't a dominance of average EU values in any of the six indicator groups.

People concentration and industry linkages are fundamental deal breakers for industry development potential between Latvia and Estonia. Despite a 30 percent larger population size in Latvia and, to this extent, related workforce numbers, the population dynamics are more favourable to Estonia. According to current demographic patterns, after 40 years, both regions will have equal population sizes. Along with the purchasing power of society, it is a fundamental factor in long-term investment attractiveness. Wealthy societies can afford to pay extra money for nature's neutral energy. Apart from Estonia, the other EU regions have an advantage in demographic dynamics and purchasing power compared to Latvia. Furthermore, the larger foreign direct investment flow to Estonia in contrast to neighbouring territories is an additional beneficial factor to support further investment inflows and new industry evolution. People's concentration and financial resources complement each other in light of the analysis conducted.

The discussion about industry linkages leads to the assumption that a more complex economy has extra linkages between different fields of economic activity within a region. Connections between the hydrogen sector and local industries that use hydrogen in their manufacturing processes are essential for long-term market security. Producing hydrogen only for export places this industry in uncharted waters of intense competition with the regions of the EU employing a more developed hydrogen industry, as well as making it more dependent on transportation costs. Until the last decade, Latvia had the potential to use hydrogen in the steel plant and Estonia in mineral fertiliser production; presently, both production sites are closed. Today, Estonia is more reluctant to use hydrogen public transportation in the largest cities, despite similar project failures in Riga public transportation.

Basic indexes describing a country's economy in terms of innovation, productivity, and complexity show that Estonia outperforms Latvia in these fields and possesses an advantage to attract investments; its claim is supported by foreign direct investment data. Moreover, Latvia's neighbour has an edge in other basic statistical indicators describing the overall situation of the country's economy, which creates a framework for a successful industry-building process.

Regarding transportation costs and infrastructure, both regions have similar situations. The main consideration in the research framework is the opportunity for transportation of produced hydrogen via natural gas pipeline infrastructure, railways, and ports. Both regions employ similar infrastructure for hydrogen transportation in gas or liquid form. Hence, transportation costs must be comparable, but a more accurate measurement is not feasible at this point in the industry's potential studies.

In addition to the results reflecting industry development opportunities in the analysed countries, there are a wide range of factors concerning the approach of the analysis itself. Firstly, while 28 criteria cannot offer a thorough assessment of patterns and initiative conditions for specific industries' development in a particular region, they can offer a detailed initial glance at the issue. Secondly, every industry has a list of individual criteria directly linked to or related only to it.

These circumstances complicate the construction of a universal assessment approach due to the requirement for ongoing modifications to the list of criteria and the harmonisation of difference coefficient values with regard to particular industry preferences. Essentially, the six basic elements of the research framework – people concentration, investments, industry linkages, transportation infrastructure, transportation costs, and particular industry evolution – have universal application capacity, but criteria within these elements need to be modified accordingly. Apart from good general economic circumstances in a particular territory, the conditions for certain industries can be unsupportive. Therefore, special criteria directly linked to the reviewed industry must have appropriate weight in the overall assessment.

Uneven distribution of 28 criteria within six indicator groups increases the value of one particular indicator over another; for example, in this assessment, industry linkages. In these circumstances, the development of a mathematically correct model is challenging. Further work must be conducted to develop a more balanced criteria distribution among the six fields of analysis.

Conclusions

1) The applied approach within the cumulative circular causation and economic geography theoretical framework in the research confirms the key assumptions about Latvia and Estonia's economic situation and industry development opportunities, reflecting Estonia's leading position with a higher score in 19 indicators out of 28. Nine of the 19 criteria representing average values in the EU were greater than in Estonia and Latvia. The major difference between both neighbouring regions represents population concentration criteria and industry linkages. Overall, in all six indicator groups, Estonia received more points than Latvia.

2) At the time of the study, both countries have similar starting positions regarding the evolution of the green hydrogen industry, and it's too early to identify whether one or the other has a massive advantage. Nevertheless, Estonia is leading in public transportation projects and possesses some edge concerning green hydrogen industry pilot projects. The main weakness for Latvia and Estonia is a lack of large-scale production that may be linked to the green hydrogen industry for mutual benefit. Furthermore, the governments of both countries need to prepare a roadmap for hydrogen industry development and utilisation in their local economies.

3) The examined data of 28 criteria is not sufficient to investigate all patterns and initiative conditions for particular industry development in a certain location, but it provides a detailed first glance at the industry's evolution potential. Additionally, more effort must be pursued to develop a better balanced criteria distribution between the six fields of analysis to prevent increases in the value of one particular indicator. Uneven value dispersion restricts the construction of a more sufficient mathematical framework for industry development assessment.

4) The value distribution between general criteria describing the overall situation in the economy and specific criteria for particular industry evaluation in the matrix is another area of concern. In an excellent general economic situation in a definite region, the conditions for a particular industry can be unsupportive. Therefore, these special criteria must have appropriate weight in assessment.

Bibliography

1. Auvetech (2023). World's first autonomous hydrogen vehicle. Retrieved from https://auve.tech/products/worlds-first-autonomous-hydrogen-vehicle/
2. Berger, S. (Ed.). (2009). *The Foundations of Non-Equilibrium Economics: The principle of circular and cumulative causation*. Abingdon: Routledge.
3. Civitta (2022). Analysis of the Hydrogen Usage in Estonia 07.2023. Retrieved from https://civitta.com/articles/analysis-of-the-hydrogen-usage-in-estonia

4. Conexus (2022). Latvia's Gas Transmission System. Retrieved from https://www.conexus.lv/latvias-gas-transmission-system
5. Elering (2022). Estonia gas system. Retrieved from https://elering.ee/en/gas-system
6. Entsog (2022). Hydrogen Project Visualisation Platform. Retrieved from https://h2-project-visualisation-platform.entsog.eu/
7. European Council (2023). European Green Deal. Retrieved from https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/
8. Eurostat (2023). Demography, population stock and balance. Retrieved from https://ec.europa.eu/eurostat/web/population-demography/demography-population-stock-balance/database
9. Eurostat (2022). Employment – annual statistics. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Employment_-_annual_statistics
10. Eurostat (2022). Maritime freight and vessels statistics. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Maritime_ports_freight_and_passenger_statistics&oldid=218671
11. Eurostat (2023). Renewable energy statistics 01.2023. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics
12. Eurostat (2022). Share for transmission and distribution in the network cost for gas. Retrieved from https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_206/default/table?lang=en
13. Friedmann, J. (1967). A General Theory of Polarized Development. Retrieved from https://repositorio.cepal.org/bitstream/handle/11362/34953/S6700361_en.pdf?sequence=1
14. Harvard University (2022). Country & Product Complexity Rankings. Retrieved from https://atlas.cid.harvard.edu/rankings
15. Higgins, B., Savoie, D.J. (Eds.). (1988). *Regional Economic Development: Essays in Honour of Francois Perroux*. Boston: Unwin Hyman.
16. Fuel Prices EU (2023). Year: 2022. Retrieved from https://www.fuel-prices.eu/archive/
17. Hirschman, O.A. (1958). *The Strategy of Economic Development*. New Haven: Yale University Press.
18. International Energy Agency (2022) Global Hydrogen Review 2022. Retrieved from https://www.iea.org/reports/global-hydrogen-review-2022
19. International Energy Agency (2019). The Future of Hydrogen: Seizing today's opportunities. Retrieved from https://www.oecd.org/fr/publications/the-future-of-hydrogen-1e0514c4-en.htm
20. International Road Federation (2022). Road network density by land area. Retrieved from https://datawarehouse.worldroadstatistics.org/
21. Invest in Estonia (2022). Estonia is preparing for a hydrogen economy. Retrieved from https://investinestonia.com/estonia-is-preparing-for-a-hydrogen-economy/
22. Knaap, T. (2004*). Models of Economics Geography: Dynamics, Estimation and Policy Evaluation*. Ridderkerk: Labyrinth Publications.
23. Krugam, P. (1981). Trade, Accumulation, and Uneven Development. Journal of Development Economics, 8(2), https://doi.org/10.1016/0304-3878(81)90026-2
24. Krugman, P. (1991). Increasing Returns and Economic Geography. Journal of Political Economy, 99(3), https://doi.org/10.1086/261763
25. Krugman, P., Livas, R.E. (1996). Trade Policy and Third World Metropolis. Journal of Development Economics, 49(1), https://doi.org/10.1016/0304-3878(95)00055-0
26. Labs of Latvia (2023). Latvia and Estonia collaborate to test potential of green hydrogen in transport sector. Retrieved from https://labsoflatvia.com/en/news/latvia-and-estonia-collaborate-to-test-potential-of-green-hydrogen-in-transport-sector
27. Meardon, J.S. (2001). Modelling Agglomeration and Dispersion in City and Country: Gunnar Myrdal, Francois Perroux, and the New Economic Geography. The American Journal of Economics and Sociology, 60(1), https://doi.org/10.1086/261763
28. Myrdal, G. (1957). *Economic Theory and Under-developed Regions*. London: Gerald Duckworth.
29. Nakamura, D. (2013). Spatial Policy for a Competitive Regional system: Economic and Social Infrastructure elements. Journal of Urban Management, 2(1), https://doi.org/10.1016/S2226-5856(18)30067-0
30. National statistical System of Latvia (2022). Population changes and key vital statistics 1920 – 2022. Retrieved from https://data.stat.gov.lv/pxweb/en/OSP_PUB/START__POP__IR__IRS/IRS010/
31. Organisation for Economic Co-operation and Development (2022). Inward FDI flows by industry. Retrieved from https://data.oecd.org/fdi/inward-fdi-flows-by-industry.htm
32. Organisation for Economic Co-operation and Development (2023). Level of GDP per capita and productivity. Retrieved from https://stats.oecd.org/Index.aspx?DataSetCode=PDB_LV
33. Organisation for Economic Co-operation and Development (2023). Purchasing power parities. Retrieved from https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm
34. Rickard, J.S. (2020). Economic Geography, Politics and Policy. Annual Review of Political Science, 23(1), https://doi.org/10.1146/annurev-polisci-050718-033649
35. Rigas satiksme (2022). Hydrogen filling station. Retrieved from https://www.rigassatiksme.lv/en/services/hydrogen-filling-station/

36. Statistics Estonia (2022). Migration. Retrieved from https://www.stat.ee/en/find-statistics/statistics-theme/population/migration
37. The Global Economy (2023). Sovereign credit ratings by country. Retrieved from https://www.theglobaleconomy.com/rankings/credit_rating/
38. Trading Economics (2023). CPI Transportation Europe 02.2023. Retrieved from https://tradingeconomics.com/country-list/cpi-transportation?continent=europe
39. Thirlwall, P. A. (2002). *The Nature of Economic Growth: An Alternative Framework for Understanding the Performance on Nations*. Cheltenham: Edward Elgar Publishing Limited.
40. United Nations Economic Commission for Europe (2023). Transport statistics Database: Railway density Retrieved from https://w3.unece.org/PXWeb/en/CountryRanking?IndicatorCode=47
41. Vesinikuorg (2022). Hydrogen Valley Estonia. Retrieved from https://vesinikuorg.ee/
42. World Bank (2022). Green Hydrogen: A key investment for the energy transition. Retrieved from https://blogs.worldbank.org/ppps/green-hydrogen-key-investment-energy-transition
43. World Bank (2022). World Development Indicators database. Retrieved from https://databank.worldbank.org/source/world-development-indicators
44. World Intellectual Property Organization (2022). Global innovation index 2022. Retrieved from https://www.globalinnovationindex.org/gii-2022-report#