

# The North and South Divide: A Drag on the Italian Economy

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**Abstract.** Over the last three decades, Italy's GDP growth has seen generally seen stagnation. In the European Union, Italy's economic development rate is among the poorer levels and is internationally recognized as a country not suitable for investment. This has directly led to a decline in Italy's international voice. When it comes to the causes of Italy's economic development stagnation, the North-South gap within Italy is one of the important reasons, which is manifested in the excessive difference between the GDP per capita of the South and the North within Italy. For a long time, the north and the south of Italy have developed differently, including the different distribution of economic pillars (this paper focuses on agriculture, industry, and tourism), the different employment patterns of workers, and the different motivations of people to engage in economic development. These differences have led to an extreme imbalance in the economic development of the north and south of Italy, especially in the south, where the level of development is lower than that of the north. Such an imbalance in economic development is undoubtedly detrimental to the overall economic development of Italy. The comparison with Germany and Spain leads to the conclusion that Italy needs to reduce the gap between the North and South of the country by improving the quality of workers, introducing advanced technologies and regulating the employment system of immigrants.

**Keywords:** Italy, Economy, North and South.

## 1. Introduction

Italy is an excellent case for studying the uneven economic development within countries in a global context, with an uneven distribution of economic pillar industries within the country, an unbalanced level of science and technology between the South and the North, and different employment systems between the South and the North. This article analyzes the existing problems of agriculture, industry and tourism in Italy, as well as the labor and employment system of immigrants, and compares Italy with neighboring countries with similar backgrounds, such as Germany and Spain to propose possible solutions to Italy's economic development dilemma.

## 2. Basic analysis of Italian economy with North-South divide

Italy is the third largest economy in the EU(European Union) and the eighth largest in the world in terms of nominal GDP, with a thriving import/export trade and active import/export relations with other countries in the EU. Yet, despite its large economical scale compared to other countries and regions in the EU, Italy's economic growth is not that promising--among the worst countries in the EU. This unsatisfying situation is evident in the highly unstable annual GDP growth rate over the last three decades (i.e. 1992-2022), with negative GDP growth occurring frequently. If inflation is considered, Italy's economy can be seen to as stagnant. According to the World Bank, its highest annual GDP growth rate is 6.644% in 2021, while the lowest GDP growth rate is -9.026% in 2020, which also shows the instability of the Italian economy partly due to the global epidemic, Italy's import and export trade is in a highly unstable state. As the import and export trade is the mainstay of the Italian economy, the impact of this round of shocks on the Italian economy is particularly obvious[1]. Italy is a well-known example within the EU and worldwide for studying regional disparities in national economic development[2]. For example, according to United Nations Statistics Division, the annual GDP per capita of Lombardy in northern Italy was €38,500 in 2017, while the annual GDP per capita of Calabria in southern Italy was €17,400 in the same year. This is less than half of the GDP per capita in Lombardy. The general trend shows that the northern part of Italy is

more developed than the southern part[3]. The imbalance in economic development is also reflected in the uneven distribution of economic pillars, such as the fact that more than 60% of the country's agriculture is located in the south and is mostly family-run and small-scale[4]. This family business is usually accompanied by unregulated labor relations, which are related to many immigrants within Italy, and the lack of regulation and long-term effective labor agreements makes the agricultural economy in the south less dynamic. A similar dilemma is faced by the industrial development within Italy, which, due to policy orientation, is mainly clustered in the north and dominated by small and medium-sized enterprises (SMEs)[5]. Compared to giant multinationals, SMEs usually do not cooperate on a large scale, which hinders the process of Italy's industrial economy, and at the same time, the large number of SMEs makes it harder for government to regulate, which may be resulting in unfair trade practice. Compared to Germany, which is known worldwide for its industry, Italy's industry is not as regulated and environmental-friendly, and the scale of transnational cooperation is even smaller, putting more pressure on the government to regulate[6]. It is clear that the lessons learned from industry 4.0 implementation in Germany can spark some ideas for Industry development in Italy. Spain, which has also faced the problem of large disparities in intra-national development levels, is addressing this problem and there are pieces of evidence to believe that the intra-national economic development gap in Spain is narrowing. Therefore, this paper will use the Spanish case to analyze feasible Italian approaches to narrowing the intra-country economic development gap[7]. In addition to the gap in economic development, the disparity between the South and the North within Italy is also reflected in the gap in national resources possessed by the local population. In the more underdeveloped South, for example, the per capita ICU resource share does not reach the national average in all regions except Sicily[8]. This paper will also discuss the inequality in public resources throughout the country.

## 2.1 Agriculture

Agriculture is one of the mainstays of the Italian economy, accounting for approximately one-sixth of GDP [9]. Most Italian agricultural field is located in the central and southern regions, dominated by family-based operations, whose unit size is smaller compared to the agricultural companies in the northern part of Italy [10]. Cereals are the largest agricultural product produced in Italy, followed by olive tree cultivation [11]. Due to the development of new energy sources, an increase in population, and technical advancements, productivity and land use have increased significantly during the last three decades. In order to integrate ecological and social perspectives, we used the human appropriation of net primary production (HANPP) framework to analyze the extent of land use by systematically quantifying biomass harvesting and the potential productivity of ecosystems versus current productivity as a result of land use processes, such as land conversion or land degradation [12].

This approach is more reliable and useful for examining the disparity in agricultural economic development between the north and the south since it considers more economic aspects. Agricultural soil HANPP in Italy has decreased from 78 percent of natural productivity before WWII to 56 percent in 2007, according to the study's findings, showing that pressures from land usage on biomass flow are diminishing with time. In addition, despite the shrinking amount of acreage, biomass production has increased by around 26% as a result of agricultural intensification. It's interesting to note that despite the fact that more than 60% of Italian agriculture is concentrated in the South, agricultural development in the North still exceeds that in the South in terms of higher yields and more economic conversions. According to one theory, despite a decline in arable land and a rise in forestry, the North has a significantly greater HANPP than the South due to higher mechanization, more advanced technologies applied to agriculture, and a more standardized production model [13]. In contrast, the Southern agricultural production model is mostly limited to small family-based workshops, and the technology applied to agriculture is traditional and old, so even though the arable land in the South is much larger than that in the North, its agricultural development is limited. Another view is that investors in the South are exposed to greater investment risks compared to the North: climate, soil,

and topography make the investment in the South riskier. These investors must face unstable hot climates, precipitation deficits, and poor harvests. In addition, due to long periods of low-tech, crude model agriculture, soils in the South face varying degrees of soil degradation, which reduces average unit yields in the South [14]. The problem of unregulated labor hiring encountered in the development of agriculture in the South and its resulting high instability of human mobility will be discussed in a unified manner in a later question.

In the face of this problem, besides non-anthropogenic factors such as topography and climate, the government can promote agricultural production in the South by enacting laws to regulate family-based production, dispatching technicians and increasing the unit price of crops, and actively developing foreign trade by taking advantage of the geographic proximity to the sea to drive the local economic development in the South, thus reducing the per capita GDP gap and economic development gap within the country.

## 2.2 Industry

With a high overall weight in the agricultural sector, similar industrial specialization, and significant presence in traditional industries like textiles, footwear, and furniture, Italy and Spain are countries with relatively similar economic compositions within the EU [15]. Additionally, they both have low activity rates, particularly among women, and low educational attainment. It is noteworthy that both nations' labor productivity growth over the past 20 years has been among the lowest in the EU. The results for the nation demonstrate the variations in worker productivity that exist even when there are no variations in industrial specialization. Thus, this is merely the result of productivity variations among industries as a whole. The aggregate specialization effect, which incorporates the impact of several specialities on high- or low-productivity industries, is added by the other effects. The weakening of the Italian international effect as a result of the economic pause should be taken into account when discussing the relatively slow process of industrial development in Italy because it captures the differences that would still exist even if each industry in both countries had the same productivity. Italian industry is more advanced in the north than the south in the country as a whole [16]. Small and medium-sized businesses are more prevalent than large industrial firms on a national level. It is challenging for those small and medium-sized industrial firms to grow into huge corporations as a result of several regional government policies. The government's encouragement of de-industrialization and the associated rise in the share of services have also contributed to a minor decline in the industry during the past two decades. As far as the labor force is concerned, the quality of the Italian labor force has improved in the last three decades, and the number of workers with a longer learning experience and higher education is increasing according to the data [17]. However, the growth rate of highly qualified workers in Italy is slower than that of Spain. For long-term industrial development, the Italian government needs to invest more in education and increase the proportion of highly qualified workers, taking into account Spain's industrial development miracle. This experience is also mentioned in the reflection of Germany's Industry 4.0 reform and development [18]. Compared with Italy, Germany has a much higher level of industry and a reasonable distribution of enterprises of different sizes. In Germany's industrial reform, they have weakened the corporate structure and strengthened corporate cooperation, focusing on the development of highly skilled functions and the introduction of ICP to improve efficiency [19]. As a large number of jobs are replaced by computers and machinery, Germany will focus on developing workers who can make choices with interdisciplinary thinking skills [20]. Additionally, for enterprise reform, Germany has chosen a strong work system to ensure the efficiency of the company's operation, which can also be learned by Italy [21].

## 2.3 Tourism

Tourism is the fastest growing and most economically profitable industry in Italy, with an estimated 43.7 million tourists visiting Italy each year and generating \$427 billion in tourism revenue. Italy is the fourth most profitable tourism destination in the world and the fifth most visited nation

overall, according to the World Tourism Organization. Rome, Florence, Milan, and Venice are Italy's top tourist destinations, and the country's highly developed tourism industry contributes significantly to the country's overall budget deficit. At the same time, the well-developed tourism industry has brought significant increases in service jobs to Italy, which greatly reduces the unemployment rate [22]. Therefore, how to better develop tourism is a good question that can promote Italy's economic growth. Italy is rich in domestic tourism resources, and space is limited, so this paper selects the Salento region in southern Italy for analysis and proposes specific ways to improve the economic efficiency of tourism. The local energy shortage, which relies heavily on energy imports (a problem encountered in other Italian tourist destinations), and the increase in the number of tourists will inevitably mean greater energy consumption and more waste legacy[23]. The local industry is actively developing a bio-waste recycling industry to generate energy, which is seen as one of the solutions to the current bottleneck of tourism development in Italy.

According to study, the region's five biggest issues with the current growth of this technology for tourism development include excessive bureaucracy, a lack of modern facilities and technology, low levels of societal acceptance, and a lack of government long-term logical planning[24]. Among them, the lack of technology and advanced facilities refers to the fact that there are few local supporting facilities for the conversion and reuse of biological waste, and the cost of conversion is relatively high. Poor social acceptability refers to the fact that the surrounding residents refuse to build local bio-waste conversion and treatment plants because they believe that the smell and waste from the plants will pollute the environment and reduce their quality of life. The first step in resolving these issues is to expand investment in science and technology, create the technology for handling biological waste, and address issues with existing technology, such as its high cost, poor conversion rate, and unpleasant odor during treatment. Secondly, it is necessary to strengthen the training of the surrounding residents and, if necessary, government subsidies, to promote the construction of more advanced bio-waste recycling plants. As for the government, relevant departments should formulate a long-term development plan that takes into account bioavailability, sustainable development, and the opinions of the surrounding residents, and pull the local economy through the development of ecotourism to reduce unemployment. Against the backdrop of global epidemics and political unrest, Italy's tourism industry has inevitably been hit by, among other things, a lack of imported energy supplies. Therefore, the development of transformative energy has become a major focus for the development of tourism [25]. Moreover, if the self-conversion of bio-waste energy can be accomplished, it can also boost other energy-consuming industries such as the industry.

## 2.4 Immigration

The issue of immigration has become one of the worldwide problems. Due to its privileged geographical position (in the center of the Mediterranean Sea), Italy has become one of the main destinations for immigrants in the world[26]. In Italy, studies on the employment mechanisms of immigrants and the impact of immigration on local economic development are not abundant. According to OCED (2014), Italy is the country with the fastest growing foreign-born population in the last two decades[27]. In this context, some people blame the country's economic stagnation on the significant growth of immigration, citing that a large number of immigrants in low-end jobs is pulling down the annual GDP per capita and taking jobs away from natives causing an increase in unemployment. While this concern is valid, studies have found that a large number of immigrants has contributed to some extent to Italy's economic development, while at the same time the legitimate rights of working immigrants are being undermined by highly irregular employment patterns (especially in the southern regions of Italy)[28]. The strong union presence on the Italian labor market, particularly when it comes to pay negotiations, is one of its key characteristics. This indicates that pay negotiations are less permissible in Italy's formal system. However, in the southern part of Italy, especially in regions where agriculture is the main economic pillar, due to the large number of low-skilled workers required by the industry and the time-sensitive nature of the crops, informal family-based agricultural production groups tend to hire illegal immigrants for labor work at lower wages,

which inevitably undermines the interests of immigrants. Locally in Italy, these people are called *caporalato*, a term with mafia connotations, or, in other words, illegal contractors. This unsophisticated employment model prevents the region's overall agriculture from developing on a larger scale, as there are no uniform rules for transforming the value of labor, and small family-based workshops prefer to develop on their own rather than join forces. Non-associated, small-unit production has limitations in economic development because it cannot take advantage of the collective branding effect of large corporations or factories, nor can it take advantage of more efficient logistics and transportation services. Arguing from this point of view, the southern Italian region needs to establish a sound mechanism for the employment of immigrants and legislation to protect their rights[29]. The Italian Parliament passed Act 199 to prohibit exploitative labor and illegal labor intermediation, defining labor exploitation as (a) the systematic payment of wages below the established salary level. (b) Systematic violation of regulations regarding working hours, weekly rest, and legal holidays. (c) Violation of laws and regulations regarding occupational safety and health. (d) Humiliating working conditions and restrictions on leaving the workplace. Despite this, there are still migrant workers in southern Italy who are employed in highly precarious labor relations.

Referring to the impact of immigration on local unemployment, the study finds that the impact of immigration on highly skilled workers is minimal, while the impact on low-skilled workers is greater. The cost of hiring short-term immigrant low-skilled workers tends to be much smaller than hiring native low-skilled workers due to immature labor relations employment, while for high-skilled workers, the increase in immigration somewhat increases their earnings. The average age of the population in Italy has risen, while population growth has decreased naturally, according to the Italian National Institute of Statistics (ISTAT). As a result, Italy is dealing with the problem of an aging population. From this perspective, the establishment of a sound system of employment and social welfare for immigrants is conducive to the optimization of Italy's demographic structure[30]. If paired with corresponding learning resources to produce more highly skilled workers, immigrants would be a demographic resource.

Italy and Spain are very similar in terms of industrial composition, so some Spanish measures to revitalize the economy could be analyzed to contribute to the Italian economy[31]. For industry and agriculture, Spain faced the problem of immature development of advanced technologies, for which they invested more in scientific research, built schools, and increased the number of years of compulsory education for the population[32]. Although this is not a measure that can be seen in the short term, in the long term, these initiatives can improve the overall cultural level of the people, reserve a large number of highly skilled personnel for the development of high technology, and also provide enough highly skilled workers for industrial and agricultural development, aligning with the Industry 4.0 reform and following the high technology industrial development route of Germany.

Spain is also facing immigration problems. The Spanish National Statistics Institute (INE) published on June 3, 2022 data on foreigners residing in Spain and obtaining citizenship in 2021, reaching 144,000, an increase of 14% over 2020, the highest figure since 2016. Faced with such a large number of immigrants, the new draft reform of Spanish immigration regulations aims to promote industries with low employment rates, accept foreign immigrants with vocational training, allow foreign students to work, and encourage entrepreneurship among foreign citizens, among other things. The overall policy manifests the economic goal that immigrants are needed to maintain the Spanish labor market and high welfare state status. Comparing to other countries in the EU facing similar immigration problems, Spain made a huge progress in establishing a series of regulations to protect the immigrant's right. For Italy, it is necessary to establish a similar policy of accepting immigrants.

Spain is highly dependent on imports for energy and has been relatively affected by the recent international conflicts. At the EU summit in Brussels in March 2022, the Spanish government fought for self-intervention in domestic energy prices. Faced with the disadvantages associated with dependence on imported energy and the specificity of the energy market in the Iberian Peninsula, where Spain is located, including a high percentage of renewable energy and where natural gas

accounts for only 15% of Spain's energy for electricity generation, the Spanish government was granted special treatment that allowed it to temporarily intervene in the domestic market and limit prices in response to the crisis. This is considered to be a hope to cope with the recent increase in energy prices due to the international conflict crisis. In addition, Spain has made significant efforts to develop energy recovery, including the reuse of bio-waste from which the Italian tourism industry can learn[33]. At a time when energy shortages are winding down, this is the only way to get to the root of the problem. When energy is abundant, the economic development of the country's mainstay industries is also guaranteed.

### 3. Conclusion

The biggest problem in Italy's nearly three decades of economic stagnation has been the uneven development within the country, i.e., the disparity in GDP per capita between the South and the North is too large. Such unbalanced development is not conducive to Italy's overall economic development, and only when the problem of unbalanced domestic development is resolved will Italy's economy be able to return to a stable growth phase. This imbalance is further constituted by the unbalanced distribution of economic pillar industries and the unequal employment relations of workers. The paper focuses on the dilemmas of agriculture, industry, and tourism concerning the imbalance in the distribution of the economic pillars. The concentration problem in these three industries lies in the lack of quality labor, or to put it differently, highly skilled workers, and advanced skills. Specifically, agriculture in the South lacks large companies with intensive production rather than small, family-based production, the industry lacks emerging technologies to replicate the economic miracle triggered by Germany's Industry 4.0 revolution, and tourism faces more serious energy problems and sustainability issues due to insufficient technologies for bio-waste utilization. As for the inequality of employment relations among immigrants, studies show that immigrants from the South are more likely to perform low-skilled, short-time labor than high-skilled, long-term employment labor. This unofficial, informal labor-employment relationship undoubtedly hurts migrants' entitlements, which in turn further undermines the local labor market, creating a vicious cycle. To change this, the Italian government should continue to improve the labor laws for immigrants after their admission and enact stimulating policies to protect the labor rights of immigrants, as well as guarantee social benefits for immigrants and increase the number of years of education to train highly skilled workers. By observing the results of these initiatives in Spain, it is easy to conclude that Italy can refer to these methods to boost its economic development.

### References

- [1] Cerami, C., Santi, G. C., Galandra, C., Dodich, A., Cappa, S. F., Vecchi, T., & Crespi, C. (2020). Covid-19 outbreak in Italy: are we ready for the psychosocial and the economic crisis? Baseline findings from the PsyCovid study. *Frontiers in Psychiatry*, 11, 556.
- [2] Usseglio, A. N. (2016). The North-South Divide: Regional Economic Inequality in Contemporary Italy.
- [3] Daniele, V., & Malanima, P. (2017). Regional wages and the north-south disparity in Italy after the unification. *Rivista di storia economica*, 33(2), 117-158.
- [4] De Lucia, C., & Pazienza, P. (2019). Market-based tools for a plastic waste reduction policy in agriculture: A case study in the south of Italy. *Journal of Environmental Management*, 250, 109468.
- [5] Lucchese, M., Nascia, L., & Pianta, M. (2016). Industrial policy and technology in Italy. *Economia e politica industriale*, 43(3), 233-260.
- [6] Manello, A. (2017). Productivity growth, environmental regulation and win-win opportunities: The case of chemical industry in Italy and Germany. *European journal of operational research*, 262(2), 733-743.
- [7] Shepherd, R., Lorente, L., Vignoli, M., Nielsen, K., & Peiró, J. M. (2021). Challenges influencing the safety of migrant workers in the construction industry: A qualitative study in Italy, Spain, and the UK. *Safety science*, 142, 105388.

- [8] Gallina, P., & Caini, S. (2021). North-south inequalities in healthcare response to Covid-19 in Italy. *International Journal for Quality in Health Care*, 33(3), mzab124.
- [9] Wikipedia contributors. (2022, July 29). Italy. In Wikipedia, The Free Encyclopedia. Retrieved 06:28, July 31, 2022, from <https://en.wikipedia.org/w/index.php?title=Italy&oldid=1101164716>
- [10] Gramm, V., Dalla Torre, C., & Membretti, A. (2020). Farms in Progress-Providing Childcare Services as a Means of Empowering Women Farmers in South Tyrol, Italy. *Sustainability*, 12(2), 467.
- [11] Malandrini, V., & Dvortsin, L. (2013). Participatory processes of agroecological innovation in organic cereal breeding: a case study from Italy. In Fourth International Scientific Symposium "Agrosym (pp. 719-725).
- [12] Niedertscheider, M., & Erb, K. (2014). Land system change in Italy from 1884 to 2007: Analysing the North-South divergence on the basis of an integrated indicator framework. *Land use policy*, 39, 366-375.
- [13] Caffini, A., & SpA-ITALY, C. T&Trac: the agriculture become 4.0.
- [14] Piccoli, I., Chiarini, F., Carletti, P., Furlan, L., Lazzaro, B., Nardi, S., ... & Morari, F. (2016). Disentangling the effects of conservation agriculture practices on the vertical distribution of soil organic carbon. Evidence of poor carbon sequestration in North-Eastern Italy. *Agriculture, Ecosystems & Environment*, 230, 68-78.
- [15] Mas, M., Milana, C., & Serrano, L. (2012). Spain and Italy: Catching up and falling behind. Two different tales of productivity slowdown. *Industrial productivity in Europe: Growth and crisis*, 161-191.
- [16] Daniele, V., & Malanima, P. (2014). Falling disparities and persisting dualism: Regional development and industrialisation in Italy, 1891-2001. *Investigaciones de Historia Económica-Economic History Research*, 10(3), 165-176.
- [17] Bernardi, F., Gangl, M., & Van de Werfhorst, H. G. (2004). The from-school-to-work dynamics: Timing of work and quality of work in Italy, the Netherlands and the United States, 1980-1998. Madrid: Instituto Juan March de estudios e investigaciones.
- [18] Veile, J. W., Kiel, D., Müller, J. M., & Voigt, K. I. (2019). Lessons learned from Industry 4.0 implementation in the German manufacturing industry. *Journal of Manufacturing Technology Management*.
- [19] Hahn, T., & Scheermesser, M. (2006). Approaches to corporate sustainability among German companies. *Corporate social responsibility and environmental management*, 13(3), 150-165.
- [20] Diessner, S., Durazzi, N., & Hope, D. (2022). Skill-biased liberalization: Germany's transition to the knowledge economy. *Politics & Society*, 50(1), 117-155.
- [21] Schaff, F. (2022). Urban political structure and inequality: Political economy lessons from early modern German cities(No. 225). EHES Working Paper.
- [22] Monaco, S. (2018). Tourism and the new generations: emerging trends and social implications in Italy. *Journal of Tourism Futures*.
- [23] Betta, L., Dattilo, B., di Bella, E., Finocchiaro, G., & Iaccarino, S. (2021). Tourism and Road Transport Emissions in Italy. *Sustainability*, 13(22), 12712.
- [24] Falcone, P. M. (2019). Tourism-based circular economy in Salento (South Italy): A SWOT-ANP analysis. *Social Sciences*, 8(7), 216.
- [25] Patterson, T. M., Niccolucci, V., & Marchettini, N. (2008). Adaptive environmental management of tourism in the Province of Siena, Italy using the ecological footprint. *Journal of environmental management*, 86(2), 407-418.
- [26] Ascoli, U. (2019). Migration of Workers and the Labor Market: Is Italy Becoming a Country of Immigration?. In *Guests come to stay* (pp. 185-206). Routledge.
- [27] Calavita, K., Tsuda, T., Martin, P., & Hollifield, J. (2006). Italy: Immigration, Economic Flexibility, and Integration. Irvine, University of California.
- [28] Reyneri, E. (1998). The role of the underground economy in irregular migration to Italy: cause or effect?. *Journal of ethnic and migration studies*, 24(2), 313-331.1990
- [29] Lipps, O., & Oesch, D. (2018). The working class left behind? The class gap in life satisfaction in Germany and Switzerland over the last decades. *European Societies*, 20(4), 549-571.

- [30] Fusaro, S., & López-Bazo, E. (2018). The Impact of Immigration on Native Employment: Evidence from Italy [WP]. AQR–Working Papers, 2018, AQR18/11.
- [31] Molina, O., & Rhodes, M. (2007). The political economy of adjustment in mixed market economies: A study of Spain and Italy. *Beyond Varieties of Capitalism: Conflict, contradictions and complementarities in the European economy*, 223-252.
- [32] Buil, P., Roger-Loppacher, O., Selvam, R. M., & Prieto-Sandoval, V. (2017). The involvement of future generations in the circular economy paradigm: an empirical analysis on aluminium packaging recycling in Spain. *Sustainability*, 9(12), 2345.
- [33] Contreras, A., Carpio, J., Molero, M., & Veziroglu, T. N. (1999). Solar–hydrogen:: an energy system for sustainable development in Spain. *International journal of hydrogen energy*, 24(11), 1041-1052.