

How green is my industry? The case of Turkey

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How green is
my industry?

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Abstract

Purpose – The purpose of this paper is to give a good overview of the relationship between industrial growth and industrial pollution in Turkey. The question is to what extent dirty industries have been affected by the regulations on the control of environmental degradation.

Design/methodology/approach – The approach for this study uses all regulations which serve for protecting human and its environment from danger arising from dirty industries in Turkey. After presenting brief explanations on green industry, next sessions explain and compare the situations of the Turkish dirty industries and its relationship with related regulations in the European Union (EU).

Findings – The authors offer three solutions. First, clean consumption should be stimulated in Turkish society. Second, Turkish Government should conduct more joint projects with the EU. Third, EU funds should be directed to cleaner production technologies to subsidize dirty industries during the negotiation process.

Originality/value – Green industry can be assessed as a steep road to build a sustainable future. For a long time, the unsustainability of current forms of industrial production has been discussed in Turkey. As a solution some argue that if governments support, industries can finance their own transformation more rapidly. However, these arguments do not mean that industries voluntarily accept these changes.

Keywords Sustainable development, Industry

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Introduction

Green industry can be assessed as a steep road to build a sustainable future. Since it requires different perspectives, regulations, technologies and institutions, it is not an easy task to convert old industries to green ones, at least it would be costly. There are green and clean technologies which have already developed by many researchers and most of these technologies are ready to use in industries, but these are expensive and this transformation can be implemented only through government policy specifically for developing countries.

According to International Energy Agency (IEA) (2012), industrial activities are 20 percent of worldwide fossil fuel-related CO₂ emissions and total emissions from industry are expected to rise between 2007 and 2050 by 74-91 percent (IEA, 2014). For a long time, the unsustainability of current forms of industrial production has been discussed. In this framework, it is argued that rather than focussing on end-of-pipe solutions industries should take proper measures for cleaner production, which is defined as “decreasing risks on human and environment by continuous application of an integrated and preventive environment strategy on products and processes” (United Nations Environment Programme (UNEP), 2002). As a step for this shifting, some argue that if governments support the industries, they can finance their own transformation more rapidly. However, these arguments do not mean that industries voluntarily accept all these changes in their production patterns. There are push factors such as regulations and directives and pull factors such as reputation,



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competitiveness and ethical reasons. Industries try to find an equilibrium between these factors for the sake of profit maximization.

The increased economic growth of Turkey has inevitably affected the relationship between the country's environment and sustainable development related to air and water pollution, soil degradation, increased waste, deforestation and climate changes. In this framework legislation have a special importance on the way of European Union (EU). In response to the EU's priority for the environmental protection on the pathway of sustainable development, Turkey has focussed on new legislations for the sake of ensuring compliance with EU legislation and adopted her National Program for the *Acquis*. In order to do this, several regulations such as control of industrial air pollution and water pollution, waste management and solid and/or hazardous waste control, control of end-of-life vehicles, control and inventory of chemicals, reduction of ozone depleting substances serve for the cleaner industrial production and try to protect human and its environment from danger arising from dirty industries.

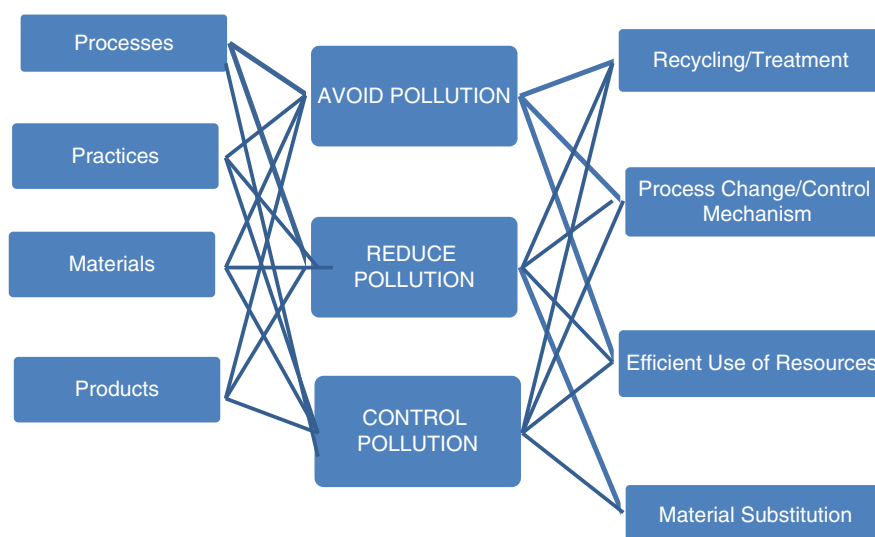
The purpose of this study is to give a good overview of the relationship between industrial growth and industrial pollution in Turkey. The question is whether dirty industries have been affected by these regulations.

The study is organized as follows. After presenting some brief explanations on green industry and its related issues, Section 2 summarizes the literature survey. Section 3 gives some connections using annual facts and figures of Turkey and make a comparison with the EU while the final section draws some conclusions.

Green industry with clean production

Since the beginning of 2000s there has been an increasing interest in cleaner production (namely, the sustainable production) by many industries all over the world. Actually the concept first emerged in 1989 at the meeting of UNEP on the global network on low and non-waste technologies. At this meeting, UNEP used cleaner production as "the continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment." This concept is based on the new managerial paradigm which includes precautionary principle that requires taking some measures before environmental impacts emerge. Despite this UNEP definition specifically during 2000s, many different definitions have appeared. The very good article of Baines *et al.* (2012) summarizes all these definitions. The common points of these definitions of cleaner production have in mutual interaction with sustainable development and minimization of environmental effects of manufacturing models. Therefore the suggested model is interested in the entire life cycle of a product which includes source reduction (green inputs), design for the environment and waste minimization (green processes), green use and green end-of-life management. For example, in order to reduce the harmful effects of inputs, cleaner production methods avoid to use toxic and/or non-renewable materials or trying to design production process related to environmental considering (Figure 1).

During the cleaner production processes, number of methodologies and tools are used: for example, Mass Balance Analyses track the inputs such as energy, raw materials, emissions and wastes. Risk Analysis Techniques assess hazard identifications, exposure situations, risk characteristics and risk management of production. Life Cycle Assessment is another technique for determining the environmental effects of production. Full Cost Accounting Method (or Environmental Accounting) considers the environmental effects into the process of determining total costs.



Source: UNEP (2004)

Figure 1.
Cleaner production:
prevention of
pollution

This proactive prevention solution could be implemented with the understanding of the firms and the system incentives. Cleaner production provides an opportunity to decrease the generation of waste and consumption of material inputs, water and energy for the industries. Therefore, as a result of using this approach, the total costs are substantially reduced. For example the companies will not pay environmental costs that will arise later on and for them reducing waste means saving money. Then the companies increase their competitiveness and reputation through the use of this cleaner production techniques.

The report called as “Changing production patterns: learning from the experience of National Cleaner Production Centers” prepared by UNEP/UNIDO (2002) based on the examples of experiences and practices of several National Cleaner Production Centers (NCPCs), summarizes the benefits of cleaner production. Besides reducing the total costs and increasing competitiveness and reputations, cleaner production improves the environmental situation and workplace quality, increases productivity and helps to adopt environmental regulations (UNEP, 2002, p. 7). This report and the following papers on NCPCs argue that the motivation of UNEP/UNIDO for these centers helps to change the production pattern of industries toward more sustainable production (Luken and Navratil, 2004). In the framework of this motivation, UNIDO offer some basic services such as seminars for awareness, training and technical assistance, advice on sources of finance and policy and information dissemination for these NCPCs all over the world.

Among all industries, some of them are more polluting-dirty industries; these are food and beverages, textiles, basic metals and non-metallic mineral products (cement, ceramics, glass and lime), chemicals and chemical products, paper, printing, publishing materials, coke, refined petroleum products. The parameters or indicators that we use in prioritization are; the consumption of water and energy, the amount of hazardous and non-hazardous solid waste generated, the amount of waste water discharged and greenhouse gases (GHGs) emissions. For example, the industries of basic metals,

non-metallic minerals and chemicals are globally most energy-intensive industries. The energy costs of these three industries have the highest share in their total input costs. Similarly the above polluting industries accounted for 76 percent of global GHGs emissions. For example, cement industry which is one of these polluting industries constitutes more than 5 percent of anthropogenic CO₂ emissions through using fossil fuels (such as coal and natural gas) in the burning process and calcination (between 50 and 60 percent of the CO₂ emitted is a result of calcination). However, according to some announcements the industry aims to voluntarily reduce carbon emissions and in order to accomplish this goal, cement industry is using clean production techniques such as using alternatives to fossil fuels (such as biomass), changing the raw ingredients in manufacture (using limestone as interground material in finished cement) and reducing the share of clinker (National Ready Mixed Concrete Association (NRMCA), 2012) and electricity use per tonne of cement. According to data from Cement Sustainability Initiative, the share of clinker in cement production decreased from 83 percent in 1990 to 75.6 percent in 2011 and the share of alternative fuel use in production increased from 2 to 13.3 percent over the same period. Similarly specific electricity use in cement decreased from 116 to 107 kWh/t (World Business Council for Sustainable Development (WBCSD), 2013). On the other hand, when synthetic chemicals are discharged this causes serious environmental degradation and human health problems. In order to block this toxic pollution, for example, paper industries began to use non-toxic inks instead of using polluting bleaches. Similarly textile industry, particularly wet processing textile plants, uses the auditing system for chemicals and necessary chemical substitutes.

Previous empirical studies and reports

There is a limited empirical research on Turkey's clean production attempts. Actually, there are two reasons for this picture; first in terms of several environmental indicators (such as Environmental Performance Index, CO₂ emissions or energy intensity) Turkey is referred as one of the weaker performance countries among the developing countries. For example, according to Yale University's Environmental Performance Index, Turkey is ranked in the 66th place among 178 countries. Similarly, in terms of carbon dioxide emissions countries data, Turkey is in the 190th place among 214 countries (World Bank, 2014) which has quite highest emissions while, in terms of per capita energy intensity Turkey's figure of 3.2 is much closer to the EU-28 average which is 3.3, however, far away from the world's average which is 6.6. So the country is ranked in the middle of the list of European countries, but in the back rows of the world list. Therefore, all these figures demonstrate the understanding and awareness of the country. But it also gives some clues about the difficulties in doing research. Second, Turkey has a data problem with detailed environmental statistics; for example detailed sectoral pollution data of Turkey are not available. This data scarcity in the country is clearly a serious problem for doing research.

Despite these data barriers there are some empirical studies and projects which have been performed. First of all, the concept of cleaner production has been first proposed by The Scientific and Technological Research Council of Turkey (TUBITAK) and The Technology Development Foundation of Turkey (TTGV) and other studies follow their pioneered works. These are mostly encouraged by TUBITAK, TTGV and Ministry of Environment and Urbanization (the ex name of this ministry was Ministry of Environment and Forest). In 1995, TUBITAK prepared a report and in this report, a structuring model was offered in order to establish the Cleaner Production Center in

Turkey. Another most influential document is the final report of the project, which is called as The Project of Determination of the Framework Conditions and R&D Needs for the Dissemination of Cleaner (Sustainable) Production Applications in Turkey (TTGV, 2010) and it was carried out in 2009. This report is one of the basic work on cleaner production; the questionnaires were sent to 128 different institutions. The project has been implemented by TTGV and MOEF. The next year, in 2011 TTGV published the book called as *Eco-Efficiency (Clean Production) in Industries-Guides, Methods and Applications*. This guide book being used relatively effectively for the city of İzmir; in 2012 final report on eco-efficiency (clean production) for the City of İzmir is published. The results of all three reports have argued and found almost the similar things:

- There are almost no awareness and sufficient consciousness on this regard in industries; some of them never have even heard of the concept; according to TTGV (2010) report the difference between pollution prevention and end-of pipe approach is not known clearly in terms of cost-benefit analysis, most industries do not make a reliable comparison between environmental investments based on end-of-pipe approach and investments related to clean productions.
- Second, there is a serious problem with the incentive mechanisms available in Turkey; financing activities do not give a sufficient incentive to support clean production. However, few private banks such as Industrial Development Bank of Turkey (TSKB), Garanti Bankası, TEB finance such activities in industries and they are using the concepts of sustainable banking and carbon footprint.
- There are some attempts to establish private Cleaner Production Centers such as The Center of Excellence on Cleaner Technologies (which is being established by Istanbul Technical University) and Sustainable Development and Cleaner Production Center (which is established by Bogazici – Bosphorus- University), but there is not any National Cleaner Production Center in Turkey.

Besides these reports, Yüksel (2008) examined the cleaner production activities in Turkey using survey responded by 42 big firms. According to his findings, proactive measures are still accepted as an obstacle in environmental management systems of these firms. In his analysis, it is concluded that pollution prevention technologies are more effective than pollution control (end-of-pipe) technologies, however, despite this result, however despite this result, the majority of large firms do not apply proactive measures for applying cleaner production techniques.

In TUSIAD's (Turkish Industry & Business Association) study on *The Adoption of Turkish Industry to EU Environment Acquis* (2007) it is argued that most of the companies have very little information on SEVESO II and REACH programmes. Some companies think that the compliance with EU legislation would adversely affect their competitiveness.

In another report which is written by the European Environment Agency, the activities in resource efficiency of Turkey are examined. According to this report, Turkey started to bring the concept of eco-efficiency on the agenda of her enterprises which helps them to minimize the production inputs such as materials, energy, water, etc. The report has mentioned about the Project for Integration of Eco-Efficiency into Production Industry which was established under the Sustainable Development and Clean Production Application and Research Centre of Bogazici University (European Environment Agency (EEA), 2011, p. 12).

Alkaya and Demirer (2014) examined the sustainable textile production in Turkey and they presented the application of different proactive measures for cleaner production in a woven fabric manufacturing mill in the city of Bursa. After basic metal industries, food industry and chemicals, textile industry is responsible for 7.6 percent of water consumption, but 12 percent of the amount of discharged water which drastically affects to water quality. They presented the results that it is possible to decrease water, salt, energy consumption as a part of the National Eco-Efficiency (Cleaner Production) Programme and they show that it reduces the CO₂ emissions (Alkaya and Demirer, 2014, p. 595).

Finally, in her dissertation Üstünışık (2014) investigates the applicability of green production in the Turkish manufacturing industry as a case of machine production. She found that the sector has a potential for energy savings and using less material. She emphasizes on re-use of the metalworks and machine tools manufacturing (Ustunisik, 2014, p. 133).

Facts and figures of Turkey's cleaner production: how far away from the EU Turkey as a candidate country has to adopt the entire EU environmental *acquis*, which comprises more than 300 legal acts, into her national legislation (Okumus, 2002). The EU and its Member States have to recognize more sustainable economy and lifestyle. Therefore the pathway of EU harmonization of Turkey has prepared many directives and regulations which are related to the environmental protection. In this framework, there are several environmental regulations directly or indirectly related to cleaner production in Turkey. However, Turkey has realized that this adaptation needs a huge financial fund; for example according to Kose *et al.* (2007) in order to meet legal environmental requirements, Turkey needs to invest approximately €60 billion (Köse *et al.*, 2007). On the other hand, in terms of the legal framework, several articles of the Environmental Law (August 11, 1983 and No. 2872) such as Article 3/h and Article 11, indirectly mention about the cleaner production and clean technologies. However, the Environmental Law is mostly based on "polluter pays principle" which represents the end-of-pipe approach. This is one of the most significant challenges for improving the idea of cleaner production in Turkish industrialists' mentality and Turkish governments.

Besides the Environmental Law, after the candidacy announcement, Turkey has accelerated environmental issues related to legalization; there are several regulations on the control of pollution caused by hazardous substances, hazardous waste, waste vegetable oils, batteries and accumulation, ozone depleting substances. During 2000s, these regulations have been successively issued. However, balancing economic growth with environmental protection has always been a problem in Turkey. There are still some legislations need to be adopted to implement the regulations on industrial pollution control and risk management. Therefore, as the European Commission's regular progress report mentioned, "the real challenge remains to conciliate growth and environmental concerns" in the country (European Commission, 2014a, p. 71).

In terms of its contribution to economic growth, Turkish manufacturing sector (ISIC 15-37) presents unstable figures; in 1980 the share of manufacturing sector in Turkish economy was 16.9 percent and this figure increased to 23.6 percent in 1998 but it decreased to 15.3 percent in 2013. For three decades, the share of manufacturing has been decreased by only 0.1 percent. However, there are two indicators which make the Turkish industry controversial; one is about electricity consumption and the other is GHG emissions; for the same period the industry's share of net electricity consumption

in total has dropped to 47.4 percent from 63.8 percent (Enerji ve Tabii Kaynaklar Bakanlığı, 2014). But the Turkish industry's total energy consumption has increased by yearly average 4 percent; from 13.71 Mtoe in 1990 to 23.38 Mtoe in 2007. Unfortunately the highest shares belong to fossil fuels; Turkey's carbon emissions have risen in line with the energy consumption. As a result of this, the GHGs emissions from industrial processes, increased from 15.5 million tons (CO₂ equivalent) to 62.8 million tons (CO₂ equivalent); there is a fourfold increase (TUIK, 2014). Therefore, it is possible to say that the manufacturing sector still contributes to the Turkey's economy, but the quality of this contribution is controversial; sometimes Turkey adopts strict sustainable production standards sometimes the country behaves like a pollution haven.

On the other hand, when we look at EU GDP, the industry's contribution is 15.1 percent in 2013 which is quite a long way from the 20 percent target for 2020 but its importance is much greater than its share in GDP (European Commission, 2014b). It is a strange coincidence in terms of contribution to GDP, but Turkish and European industries have different characteristics from each other. For example, between 1990 and 2009 the electricity consumption of industrial sector in the EU-27 decreased by 0.7 percent, which was due to the drastic fall in the new member states (EU-12). But the main difference between these industries comes from GHGs emissions; between 1990 and 2012 GHGs emissions decreased by 15 percent in EU-15 and percent by 19.2 percent in EU-28. In 2012, EU-15 emissions were 15.1 percent below the base year emission levels under the Kyoto Protocol's first commitment period, which constituted a net reduction of 646 million tons of CO₂ equivalent (EEA, 2014). This decline is due in part to the recession as well as the use of clean technologies such as using renewable in final energy consumption. According to Eurostat data, the share of renewable energy in gross final energy consumption reached to 14.1 percent in 2012. After the road transportation another largest decrease in emissions occurred in manufacturing industries and construction, including iron and steel. So the main difference comes from the trend of GHGs emissions; Turkey is increasing its emissions while EU hopes to benefit by decreasing GHGs emissions.

Cleaner production is a process that must go hand in hand with clean consumption. Under the directives of the EU, production of many durable and non-durable consumer goods have to focus on energy savings and other environmental aspects during their designs and processes. For example, Ecodesign Directive (2005/32/EC and 2009/125/EC) regulates the environmental impacts of more than 40 electrical product groups such as boilers, water heaters, air conditioning, fridges, computers or televisions. In order to catch EU sustainable production and consumption standards, several directives on energy efficiency have been implemented by Turkish authorities. The overall regulatory framework includes law, regulations and notifications such as: Energy Efficiency Law (2007) Regulation on Efficient Utilization of Energy Resources and Energy (2008), Regulation on Building Energy Performance (2008) (based on Directive 2002/91/EC), Regulation on Appointment of Energy Managers in Schools (2009), Regulations on Energy Labelling of several Products (based on Directive 2010/30/EU) and Notifications on Energy Efficiency Incentives (2012), and Energy Efficiency Training and Certification Activities (2012) (Enerji ve Tabii Kaynaklar Bakanlığı, 2014).

On the other hand, with the cooperation of EU countries, there are some projects on capacity building in industrial pollution control or raising awareness about some EU programmes such as REACH. Most of these projects ensure the strengthening the institutional capacity on controlling the industrial pollution, training of trainers or

implementation of directives. For example, Dutch/Turkish G2G Project is one of them. Another Project is Eco-Industrial Park Environmental Support System, which aims to reduce industrial environmental impact using specifically designed software. Particularly this tool helps to identify the cost-efficient measures for environmental improvements (www.bsn-anatolia.org.tr). In 2010 Industrial Symbiosis-Industrial Ecology Project in Iskenderun Bay was started by TTGV and BTC Company (Baku-Tiflis-Ceyhan Crude Oil Pipeline Company) (TTGV, 2015). The Project aims to establish the technical and administrative infrastructure for implementing industrial symbiosis applications and it considers economical and environmental advantages together (www.endustriyelsimbiyoz.org/).

The textile industry is one of the most important strategic industries of Turkish manufacturing; in terms of value added textile industry has 8.08 percent share in total value added and this industry has the third biggest share after automotive (11.59 percent) and food and beverages (9.96 percent) industries (TUSIAD, 2014, p. 20). In the textile industry, dyeing and printing consume quite a large amount of water (15 percent of water consumption in industrial water consumption) and chemicals, and at the same time the industry release numerous volatile agents into the atmosphere which have harmful effects on human health (Ozturk *et al.*, 2009). In terms of controlling industrial pollution, there are two stages of approach in the sector: the application of inhouse control and purification of waste water. The Turkish textile industry, mostly focusses on the removal of the purified waste water from the factory. Therefore the investment and operation costs of treatment system increase. Actually, it is possible to decrease water consumption and the pollutants which can be found in waste water, using in-house techniques. However, as we mentioned before, the Turkish textile industry prefers end-of-pipe solutions.

Turkey's cement industry shows a rising trend; cement consumption per capita in Turkey (765 kg) is more than world (500 kg) and Europe's (365 kg) averages. In Turkey cement plants hold almost all required environmental permits and according to TUSIAD (2007, pp. 100-101) study cement manufacturers have invested in environmental devices such as electrostatic dust collector filters and they have upgraded these systems regularly. In most of these manufacturers emissions are automatically monitored and recorded. At the same time, with the help of the high temperatures used in the cement production, most of these cement factories have received an incineration license from the Ministry.

Conclusion

Sustainable production has been a hot debate in the last two decades due to the massive pollution produced by manufacturing industries. For this reason, industries have to be transformed in a way that they shift to cleaner production and production-related pollution reduces. This hard task can be achieved by push factors such as regulations and directives and pull factors such as reputation, competitiveness and ethical reasons. However, it is not easy to balance these two aspects.

Turkey seems to be caught on the horns of a dilemma. On the one hand, as a developing country, Turkey has to achieve high economic growth for increasing welfare of its people. On the other hand, Turkey also has to adopt the whole EU environmental *acquis* in order to be a full member of the EU.

One way to deal with the dilemma is to stimulate clean consumption for which many regulations have been implemented in the last years. Second, there have to be more joint projects with the EU that aims to improve institutional structure and provide

environmental training for employees. In addition to these efforts, there should be EU funds specifically directed to cleaner production technologies. With these funds, the government could subsidize dirty industries during the transition period, and by this way, the economy does not contract owing to environmental regulations.

References

- Alkaya, E. and Demirer, G.N. (2014), "Sustainable textile production: a case study from a woven fabric manufacturing mill in Turkey", *Journal of Cleaner Production*, Vol. 65, pp. 595-603, available at: www.journals.elsevier.com/journal-of-cleaner-production/
- Baines, T., Brown, S., Benedettini, O. and Ball, P. (2012), "Examining green production and its role within the competitive strategy of manufacturers", *Journal of Industrial Engineering and Management*, Vol. 5 No. 1, pp. 53-87.
- Enerji ve Tabii Kaynaklar Bakanlığı (2014), "Yenilenebilir Enerji Genel Müdürlüğü", available at: www.eie.gov.tr/verimlilik/v_mevzuat.aspx (accessed January 4, 2015).
- European Commission (2014a), "Turkey progress report", available at: http://ec.europa.eu/enlargement/pdf/key_documents/2014/20141008-turkey-progress-report_en.pdf (accessed January 2, 2015).
- European Commission (2014b), "Commission calls for immediate action for European Industrial Renaissance", EC Press Release Database, available at: http://europa.eu/rapid/press-release_IP-14-42_en.htm (accessed January 3, 2015).
- European Environment Agency (EEA) (2011), "EEA member and cooperating countries", Survey of Resource Efficiency Policies, available at: www.eea.europa.eu (accessed January 1, 2015).
- European Environment Agency (EEA) (2014), "Why did greenhouse gas emissions decrease in the EU in 2012", available at: www.eea.europa.eu/publications/why-did-ghg-emissions-decrease (accessed January 3, 2015).
- International Energy Agency (IEA) (2012), "Energy technology perspectives 2010: scenarios and strategies to 2050", available at: www.iea.org/techno/etp/etp10/english.pdf (accessed January 10, 2015).
- International Energy Agency (IEA) (2014), "Key world energy statistics", available at: www.iea.org/publications/freepublications/publication/KeyWorld2014.pdf (accessed January 10, 2015).
- Köse, H.Ö., Ayaz, S. and Köroğlu, B. (2007), *Waste Management in Turkey: National Regulations and Evaluation of Implementation Results* Turkish Court of Accounts, TC Sayıştay Başkanlığı, Ankara.
- Luken, A.R. and Navratil, J. (2004), "A programmatic review of UNIDO/UNEP national cleaner production centres", *Journal of Cleaner Production*, Vol. 12, pp. 195-205, available at: www.journals.elsevier.com/journal-of-cleaner-production/
- National Ready Mixed Concrete Association (NRMCA) (2012), "Concrete CO₂ fact sheet", available at: www.nrmca.org/sustainability/CONCRETE%20CO2%20FACT%20SHEET%20FEB%202012.pdf (accessed December 21, 2014).
- Okumus, K. (2002), "Turkey's Environment. A review and evaluation of Turkey's environment and its stakeholders", EU European Commission (Ed.), available at: http://documents.rec.org/publications/TurkeysEnvironment_May2002_EN_1.pdf (accessed January 2, 2015).
- Ozturk, E. *et al.* (2009), "A chemical substitution study for a wetprocessing textile mill in Turkey", *Journal of Cleaner Production*, Vol. 17, pp. 239-247, available at: www.journals.elsevier.com/journals-of-cleaner-production/
- TTGV (2010), "Project of determination of the framework conditions and R&D needs for the dissemination of cleaner (sustainable) production applications in Turkey", available at: www.ttg.gov.tr/en/cleaner-production (accessed December 8, 2014).

- TTGV (2015), "Industrial symbiosis: cooperation networks for environmental and economic benefits", available at: www.ttgiv.org.tr/en/industrial-symbiosis-cooperation-networks-for-environmental-and-economic-benefits (accessed January 10, 2015).
- TUIK (2014), "Çevre ve Enerji İstatistikleri", available at: www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=1578 (accessed January 3, 2015).
- TUSIAD (2007), *Sanayiye AB Çevre Mevzuatına Uyum*, Yay, T-2007-05-440, TUSIAD, İstanbul.
- TUSIAD (2014), "İmalat Sanayi Sektörleri Rekabet Göstergeleri Raporu", available at: <http://ref.sabanciuniv.edu/sites/ref.sabanciuniv.edu/files/imalatsanayisektorlerirekabetraporu.pdf> (accessed January 18, 2015).
- United Nations Environment Programme (UNEP) (2002), "Understanding cleaner production", available at: http://unepie.org/pc/cp/understanding_cp/home.htm (accessed March 20, 2015).
- UNEP (2004) "Voluntary environmental initiatives for sustainable industrial development concepts and applications", p. 8, available at: www.unep.org/pdf/rowa/ROWA92-807-2480-0.pdf
- Üstünışık, Z.N. (2014), "Türkiye İmalat Sanayiinde Yeşil İmalat Uygulanabilirliği: Makina İmalat Sanayii Örneği", Kalkınma Bakanlığı Uzmanlık Tezi, available at: www.kalkinma.gov.tr/Lists/Uzmanlk%20Tezleri/Attachments/370/uztez-nzerrin.pdf (accessed January 10, 2015).
- World Bank (2014), "World Bank Data: CO2 emissions (metric tons per capita)", available at: <http://data.worldbank.org/indicator/EN.ATM.CO2E.PC>
- World Business Council for Sustainable Development (WBCSD) (2013), "New data for cement industry shows reduction in CO₂ emissions", available at: www.wbcscement.org/pdf/World%20Cement_Sep%202013.pdf (accessed December 21, 2014).
- Yüksel, H. (2008), "An empirical evaluation of cleaner production practices in Turkey", *Journal of Cleaner Production*, Vol. 16 No. 1, pp. 50-57, available at: <http://ec.europa.eu/environment/eco-innovation/projects/en/projects/epesus> (accessed January 10, 2015)

Further reading

- Top, Y. (2015), "Waste generation and utilisation in micro-sized furniture-manufacturing enterprises in Turkey", *Waste Management*, Vol. 35, pp. 3-11, available at: www.journals.elsevier.com/journal-of-cleaner-production/

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