

# Increasing Reliance on Wood Energy? A Case Study on Policy-Practice Interface in Selected European Countries

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## Abstract

The European Union's (EU) policies emanated during the last decade in the energy, climate and rural development sectors, foster an increased reliance on wood energy as a contribution to achieving low carbon economy. While evidence exists that stakeholders from three EU Member States (MSs) with different characteristics (Germany, Slovenia and Spain) were often uncertain about the feasibility of applying the EU's policy ambitions, they support the EU's discourses regarding the role of wood energy in boosting the competitiveness of the forest sector, contributing to climate change reduction and maintaining different forest functions. In order to achieve an increased reliance on wood energy, EU policy makers are encouraged to consider using positive considerations of the wood energy role to underpin their strategies and, at the same time, work on reducing the effects of environmental trade-offs by prioritising at supranational level the policy objectives that affect the environment.

## Goal

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In order to build a long-term energy strategy that strives for a low-carbon economy, the European Union (EU) has set policy goals for 2020, 2030 and 2050 that aim at increasing the use of renewable energy sources (European Commission, 2009; European Union, 2014; 2018). Wood energy, here defined as woody biomass harvested directly from forests<sup>2</sup> and used for energy purposes, is one of the strongholds of this strategy (Ferranti, 2014). This is evident in the 45 % contribution of wood energy

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2 In line with other studies (e.g. Mantau et al., 2010), this article excluded wood from plantations because in the European context these are often referred to as agricultural products.

to the 2016 EU’s gross consumption of renewable energy sources (Eurostat, 2018) and also in the climate, energy, forestry and rural development policy developments taking place from the early 2000s onwards. Despite the enthusiasm of EU policies, different stakeholders from the energy, climate and forestry realms expressed their worries with respect to the feasibility of EU goals concerning wood energy. The struggle between different stakeholders’ perspectives highlights the complex policy and practical drawbacks of dealing with wood as an energy source (e.g. depletion of the carbon stocks and reduction of forest capacity to contribute to climate change mitigation) (Berndes et al., 2016; Schyns and Vanham, 2019; Searchinger et al., 2018).

### **Policy Client/Audience/Target group**

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The main audience for this paper represent EU policy makers and officials from EU General Directorates dealing with environmental, energy, climate, agriculture and rural development domains. Additionally, it targets national and sub-national legislators and representatives of those institutions that ought to implement EU requirements at lower policy levels. To a minor extent, the paper can also be interesting for non-governmental stakeholders at international, national and local levels, as they are directly involved in the implementation of EU policies on the ground.

### **Policy Aims**

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In the last two decades, various policy documents (e.g. European Commission, 2013; 2014; European Parliament and Council, 2013) and legislation (e.g. Directive 2009/28/EC, named Renewable Energy Directive or RED, and Directive 2018/2001/EU or RED II) were produced, which point to the need to increase reliance on wood energy. Based on the idea that European forests encompass a currently unexploited reservoir of wood (Asikainen et al., 2008) and that wood energy is characterised by “carbon-neutrality”<sup>3</sup> (Bright et al., 2012; Ferranti, 2014), EU documents praise wood energy’s role in constituting a valuable substitute to fossil fuels, generating income in rural areas and an important element in the solution of the climate change problem (European Commission, 2004; 2005; 2009; Faivre et al., 2018; Ferranti, 2014).

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3 The assumption of the “carbon neutrality” of wood holds that the biomass extracted from the forest and burned in the energy generation process is, in the long run, replaced by new biomass growth in the forest, which re-absorbs the carbon emitted by the process of energy generation (Czeskleba-Dupont 2012). In this sense, the carbon emitted when generating energy from wood is perceived as staying in the atmosphere for a rather short time frame and is set against the emissions generated by fossil fuels, which have a much slower recovery time and are supposed to stay in the atmosphere for a very long time (Bright et al. 2012).

In the EU, different policy sectors expressed a marked interest towards the production and use of wood energy (Mantau et al., 2010). Two main factors determine such convergence in policy interests: 1) the cross-cutting character of debates on wood energy which range over economic, ecological and social aspects (Söderberg and Eckerberg, 2013) and 2) the missing legally binding EU framework directly addressing forests and their products (Winkel et al., 2009), which stimulates the interest of exogenous policies towards forest-related topics. They envisage an increased production of wood energy, but as framework policies, they point at a general principle of integration amongst competing forest functions such as wood production and nature conservation (Jordan, 2000; FERN, 2011).

## **Background to the Problem**

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In literature, the enthusiasm expressed by policy documents is counterbalanced by the awareness that increasing reliance on wood energy can pose concrete risks for the environment (Beiträge und Standpunkte aus dem Öko-Institut, 2018; Searchinger et al., 2018; Schyns and Vanham, 2019). This awareness has played a growing role also in EU policies, which took increasingly into account the possible negative consequences of using wood energy without applying the necessary sustainability measures (IEA Bioenergy, 2018; ICCT, 2018). The recognition of these risks is also strong amongst stakeholders of the forest and energy sectors. Different representatives of the scientific arena and of civil society expressed their worries with respect to the possible negative consequences and limited feasibility of satisfying the EU's policy objectives related to wood energy (Searchinger et al., 2018; WWF European policy Office, 2018; FERN, 2018; Beiträge und Standpunkte aus dem Öko-Institut, 2018; Matthews et al., 2018; Euractiv, 2018a). These stakeholders considered the sustainability precautions taken by EU policies as inadequate (e.g. FERN, 2018). They also claimed that, as other framework policies emanated in the EU (Jordan, 2000), EU legislation, dealing with wood energy, expresses common goals for EU Member States (MSs) and point at a general principle of integration amongst competing forest functions such as wood production and nature conservation.

In doing so, they do not indicate concrete solutions either for increasing wood energy production or for the environmental trade-offs associated with this production (FERN, 2011; Schulze et al., 2012). The solution of these trade-offs is left to the leeway of MSs (Jordan, 2000), which must transpose and apply EU policies sometimes facing a low acceptance by stakeholders and related implementation problems (Majone, 1999). Next to the stakeholders who blame the EU's approach to wood energy for being unsustainable, other actors, and especially forest owners and representatives of the economic sectors linked to bio-energy, criticise the approach of current EU policies for completely opposing reasons. They are concerned that, in the name of sustainability, the RED II imposes too many restrictions to the use of

wood energy (CEPF, 2017a) and it undermines the economic viability of sustainable forest management (CEPF, 2017b).

The RED and other EU policies we mentioned above did not provide practical indications on how to increase wood energy production. Therefore, in order to acquire the details characterising the different stands stakeholders take on the concrete possibilities to implement the EU’s goals of increasing reliance on wood energy, we built the framework for our analysis concentrating on concrete options for increasing wood energy production. To select these options, we drew on scientific literature that proposed scenarios of future wood energy production in the EU (e.g. European Environmental Agency, 2007; Mantau et al., 2010; Verkerk et al., 2011b). These scenarios suggested changes in ongoing wood exploitation patterns such as expanding the forest area available for wood supply and/or increasing the wood supply from existing sources. Based on these scenarios, we focused on three concrete alternatives for increasing wood energy production, which were an inspiration for our inquiry into stakeholders’ perspectives: 1) increasing the area where wood energy is harvested; 2) changing existing forest management practices to obtain wood energy and 3) exploiting tree components not traditionally harvested for energy production.

This paper is rooted in the idea that the successful national and local implementation of international policies does not only depend on the legal transposition in national systems (Yanow, 1996), but also on society’s acceptance of the rationale behind (and scope of) policy requirements (Fischer, 2000; Alphantery and Fortier, 2001). This is particularly true in decentralised contexts such as the EU, where national transposition of supranational frameworks is supposed to steer local outcomes towards common goals (Jordan, 2000). In the analysis of stakeholders’ perspectives about the EU’s goals of increasing reliance on wood energy, we considered these perspectives as a litmus paper which gives an indication of the level of compatibility between policy ambitions and the reality of the wood energy context (Fischer, 2000; Posavec et al., 2015; Pezdevšek Malovrh et al., 2016). Some of the studies we used as reference for our research made it clear that, to achieve an increased wood energy production, early 2000s’ wood exploitation patterns needed to be changed by taking society’s acceptance of eventual changes into account (European Environmental Agency, 2007; Mantau et al., 2010).

## **Alternatives**

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Looking into stakeholders’ opinions on the feasibility of three concrete alternatives for increasing wood energy production allowed us to carry out an in-depth analysis of the policy-practice interface regarding the increase of such production. None of the three alternatives was univocally perceived by stakeholders, who expressed both positive and negative opinions on the possibilities of implementing them. Conse-

quently, in some instances, stakeholders' perspectives coincided with the EU's policy ambitions, while in others they were discordant. For example, stakeholders' perspectives resonated well with the view expressed by EU policy documents on the role of wood energy in achieving economic competitiveness of the forest sector (European Parliament and Council, 2013). Forest operations such as thinning young and middle-aged forests as a means to apply the alternative of changing the existing forest management practices, and the different means related to the alternative of changing tree components destined to the energy industry, were attributed positive externalities, such as increasing revenues in rural areas and diversification of rural economy. However, several stakeholders raised the sustainability dilemma regarding these alternatives. Furthermore, the EU policy's discourse on positive mutual influences between climate and energy goals (European Commission, 2014) found a correspondence in stakeholders' perspectives. With respect to applying the alternative of changing forest management practices, some stakeholders referred to the possibility of using native rapidly growing species and perceived this as an opportunity to foster forest adaptation to climate change. As an example, whole tree harvesting and stump removal were characterised by legal limitations in all countries and not perceived as concrete solutions for applying the alternative of changing forest management practices. This view coincided with EU policy goals of opting for the integration of different forest functions and avoiding overlooking forest sustainability limits (European Commission, 2013).

Despite the fact that wood energy plays different roles in the three MSs under study, the relations between round wood and wood energy production were found strong in all three cases. Wood energy production played mainly a side-stream role to the production of round wood, which confirms the results of other similar studies (e.g. Díaz-Yáñez et al., 2013). According to our interviewees, wood energy was mostly obtained from full trees or stem-wood from thinning and from residues of final felling. In some instances, wood energy in Slovenia and Spain was also produced from primary products of final felling operations. This data shows that the picture of wood energy production was slightly different from that depicted by Díaz-Yáñez et al. (2013), especially in countries where the material wood industry was not very vital. Producing wood energy in some cases represented the main goal of forestry operations and somehow it became loose from the strict linkages that traditionally tied it to the production of round wood. The growing economic relevance of wood energy triggers a progressive strengthening of its role in determining the final goals of forest management activities.

This result unveils the early signs of a tendency that some stakeholders of the forest sector nowadays fear a growing intensification of forestry activities with the goal of producing more wood energy (Euractiv, 2018b; FERN, 2018). Today, this tendency is seen by some stakeholders (especially nature conservationists and scientists) as a misinterpretation of the positive contribution that wood energy can play in low carbon economies (Euractiv, 2018b), if compared to the traditional use

for energy purposes of the sole wood components that had no value as material. In light of these negative opinions, these stakeholders currently express negative feelings about EU legislation such as RED and RED II, which, in their eyes, promote the use of wood energy without considering the environmental dangers associated to an increased reliance on this energy source (Beiträge und Standpunkte aus dem Öko-Institut, 2018; FERN 2011, 2018). The categories of stakeholders that nowadays put forward their perplexities about the weak level of sustainability characterising EU policy ambitions are the same that, in the present study, expressed the most negative opinions about the feasibility of an increased reliance on wood energy. In conclusion, in all the three countries under analysis, wood energy was also attributed a positive connotation and was depicted as a chance to diversify rural economy, revitalise national forest sectors, support environmental forest functions such as fire prevention and contribute to climate change reduction. Stakeholders who hold these positions often relied on the idea that no real obstacles were in the way of increasing production of wood energy due to the existing reservoir of wood hosted in European forests.

The cross-country comparison highlighted that wood energy had different roles in the three case study countries, but that two important similarities between the countries existed. The first was a strict relationship between the productivity of the wood-processing industry and the role played by wood energy in national economies and in the imaginary of stakeholders. The more important the role of material uses, the less significant the role of wood energy. The second similarity was a correlation between the perceived (or hoped for) future vitality of the wood-processing industry and the confidence of national stakeholders in the increased future reliance on wood energy. When stakeholders foresaw or hoped for a vital future role of the wood-processing industry, they also considered less realistic an increased reliance on wood energy. Germany offers a straightforward example of the functioning of these two rationales; the country had the most productive forest sector compared to the other two MSs (Lindstad et al., 2015) and German interviewees perceived that wood energy was produced exclusively from low-quality wood assortments that were not used for material uses. Next to the influence exercised by the role of material wood in the country, a strong awareness about environmental trade-offs played a role in shaping the perspectives of German interviewees. Similarly, the results obtained for the Slovenian case resonate well with the two rationales presented in the previous paragraphs. Slovenia was characterised by a very limited production of round wood compared to Spain and Germany. Slovenian stakeholders described the weakness of the round wood industry and a depressed forestry economy. This explained why, at the time of the study, some of the Slovenian wood which could have been used for material uses was instead destined to the energy industry. Lastly, in Spain, material uses of wood were gradually decreasing in importance, hand in hand with the crisis of the building sector which affected especially the production of particle boards. Wood energy was positively perceived by stakeholders as an op-

portunity to make fire prevention interventions profitable. Differently from most other stakeholders, Spanish interviewees did not express any worries about negative consequences of increasing the use of low-quality trees to apply the alternative of changing forest management practices.

## **Stakeholder Analysis**

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In order to provide a varied picture of the wood energy contexts characterising different areas of the EU, whilst limiting the retrieval of information about stakeholders' perspectives to an easily displayable quantity of data, we selected three EU MSs, namely Germany, Slovenia and Spain. These MSs were chosen because they were characterised by different historical, social and economic conditions, by different traditions linked to the use and import-export of (energy) wood and by varying national approaches towards the future role of wood (e.g. Lindstad et al., 2015). For each country, we acquired opinions expressed by five stakeholder groups, chosen to cover as much as possible the different categories of actors that played a role in the wood energy context, and in particular:

- *Conservation group* (nature-conservation bodies, e.g. associations and state agencies);
- *Economy group* (industries and associations representing end users of timber and wood energy);
- *Policy group* (representatives of national Ministries and especially of forest administrations);
- *Practitioners group* (forest-owners' associations, forest enterprises and foresters);
- *Science group* (scientific institutions, researchers and experts).

## **Consultations**

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Consultation between representatives of conservation groups and representatives of economy and practitioner groups (all from various levels) is highly recommended in order to discuss the various positions and arguments, to negotiate the most beneficial solutions and to prioritise it, together with several policy objectives that affect the environment.

## **Policy Recommendation**

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European discourses on the economic role of wood energy as a booster for the competitiveness of the forest sector did find fertile ground in national implementation contexts. We suggest that policy makers interested in fostering an increased reliance on wood energy base their policy strategies on these positive properties attributed

to wood energy. On the other hand, we suggest that policy makers, both at EU and national levels, better address policy weaknesses regarding environmental trade-offs associated with wood energy production. This could be done, for example, by clearly setting at supranational level the priorities between wood energy and environmental policy goals and exploring concrete options for increasing wood energy production without harming the environment. This prioritisation of policy goals at EU level would reduce criticism by stakeholders about the fact that, in the EU, the solution of trade-offs associated with wood energy production is left at the national levels to solve. It would also reduce divergence between policy ambitions and stakeholders’ perspectives on the possibilities to increase wood energy production, as well as reducing obstacles to the achievement of EU policy goals (Majone, 1999).

## Conclusion

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This paper is grounded on the analysis of the degree of correspondence between the EU’s policy ambitions with respect to wood energy and the perspectives of national stakeholders about the possibilities of increasing reliance on this energy source in three EU MSs with different characteristics (Germany, Slovenia and Spain). The paper offers evidence concerning the level of compatibility between supranational policy objectives and lower contexts, thus supporting policy decisions and designing viable policy instruments aimed at increasing reliance on wood energy, as well as for improving convergence between supranational policy goals and practical outcomes in the EU (Jordan, 1999; Dimitrova and Steunenberg, 2000; Boerzel, 2001).

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## References

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- Asikainen, A., Liiri, H., Peltola, S., Karjalainen, T., Laitila, J., 2008. Forest energy potential in Europe (EU27). Working Paper of the Finnish Forest Research Institute. Helsinki: p. 33.
- Beiträge und Standpunkte aus dem Öko-Institut, 2018. Erosion of European sustainability requirements for bioenergy. <https://blog.oeko.de/erosion-of-european-sustainability-requirements-for-bioenergy/> (accessed 20 December 2018).
- Berndes, G., Abt, B., Asikainen, A., Cowie, A., Dale, V., Egnell, G., Lindner, M., Marelli, L., Paré, D., Pingoud, K., Yeh, S., 2016. Forest biomass, carbon neutrality and climate change mitigation. From Science to Policy 3, European Forest Institute: p. 7.

- Boerzel, T. A., 2001. Non-compliance in the European Union: pathology or statistical artefact? *J. Eur. Public Policy* 8, 5: 803–824.
- Bright, R. M., Cherubini, F., Astrup, R., Bird, N., Cowie, A. L., Ducey, M. J., Marland, G., Pingoud, K., Savolainen, I., Strømman, A. H., 2012. A comment to “Large-scale bioenergy from additional harvest of forest biomass is neither sustainable nor greenhouse gas neutral”: Important insights beyond greenhouse gas accounting. *Global Change Biology Bioenergy*, 4, 6: 617–619.
- CEPF, 2017a. Sustainably managed forests are a proven source of sustainable biomass for bioenergy. [http://www.cepf-eu.org/sites/default/files/document/20171004\\_RED\\_recast\\_Joint\\_Position.pdf](http://www.cepf-eu.org/sites/default/files/document/20171004_RED_recast_Joint_Position.pdf) (accessed 15 November 2018).
- CEPF, 2017b. Europe’s foresters deeply concerned about REDII. <http://www.cepf-eu.org/news/europe’s-foresters-deeply-concerned-about-redii> (accessed 20 December 2018).
- Czeskleba-Dupont, R., 2012. A secular carbon debt from atmospheric high temperature combustion of stem wood? *Journal of Transdisciplinary Environmental Studies*, 11, 2: 38–47.
- Díaz-Yáñez, O., Mola-Yudego, B., Anttila, P., Röser, D., Asikainen A., 2013. Forest chips for energy in Europe: Current procurement methods and potentials. *Renew Sustain Energy Rev* 2: 562–571.
- Dimitrova, A., Steunenbergh, B., 2000. The Search for Convergence of National Policies in the European Union: An Impossible Quest? *Eur. Union Polit.* 1: 201–226.
- Euractiv, 2018a. Letter from scientists to the EU Parliament regarding forest biomass. <https://www.euractiv.com/wp-content/uploads/sites/2/2018/01/Letter-of-Scientists-on-Use-of-Forest-Biomass-for-Bioenergy-January-12-2018.pdf> (accessed 20 December 2018).
- Euractiv, 2018b. Five reasons why the EU’s bioenergy policy will backfire. <https://www.euractiv.com/section/energy/opinion/forests-five-reasons-why-the-eus-renewable-policy-will-backfire/> (accessed 20 December 2018).
- European Commission, 2004. Communication from the Commission to the Council and the European Parliament – The share of renewable energy in the EU. Commission Report in accordance with Article 3 of Directive 2001/77/EC, evaluation of the effect of legislative instruments and other Community policies on the development of the contribution of renewable energy sources in the EU and proposals for concrete actions. <http://www.managenergy.net/resources/390> (accessed 20 December 2018).

- European Commission, 2005. Communication from the Commission: Biomass action plan. [http://europa.eu/legislation\\_summaries/energy/renewable\\_energy/l27014\\_en.htm](http://europa.eu/legislation_summaries/energy/renewable_energy/l27014_en.htm) (accessed 20 December 2018).
- European Commission, 2009. 2020 climate & energy package. [https://ec.europa.eu/clima/policies/strategies/2020\\_en](https://ec.europa.eu/clima/policies/strategies/2020_en) (accessed 15 November 2018).
- European Commission, 2013. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new EU Forest Strategy: for forests and the forest-based sector. [http://ec.europa.eu/agriculture/forest/strategy/communication\\_en.pdf](http://ec.europa.eu/agriculture/forest/strategy/communication_en.pdf) (accessed 15 November 2018).
- European Commission, 2014. 2030 Climate & Energy Framework. [https://ec.europa.eu/clima/policies/strategies/2030\\_en](https://ec.europa.eu/clima/policies/strategies/2030_en) (accessed 15 November 2018).
- European Commission, 2018. 2050 Long-Term Strategy. [https://ec.europa.eu/clima/policies/strategies/2050\\_en](https://ec.europa.eu/clima/policies/strategies/2050_en) (accessed 20 December 2018).
- European Parliament and Council, 2013. Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005. <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:347:0487:0548:en:PDF> (accessed 20 December 2018).
- European Union, 2009. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. (Brussels).
- European Union, 2018. Directive 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Brussels).
- Eurostat, 2018. Wood as a Source of Energy. [https://ec.europa.eu/eurostat/statistics-explained/index.php/Wood\\_as\\_a\\_source\\_of\\_energy](https://ec.europa.eu/eurostat/statistics-explained/index.php/Wood_as_a_source_of_energy) (accessed 7 November 2018).
- Faivre, N., Rego, F., Moreno, J. M., Vallejo, V. R., Xanthopoulos, G., 2018. Forest Fires – Sparking firesmart policies in the EU. Research & Innovation Projects for Policy. DG Research and Innovation. European Commission. Luxembourg: p. 48.
- Ferranti F., 2014. Wood energy: A challenge for European forests; Potentials, environmental implications, policy integration and related conflicts. EFI Technical Report 95: p. 158.

- FERN, 2011. The new Forest Strategy. [http://www.fern.org/sites/fern.org/files/FERN\\_review\\_forestry\\_strategy\\_110908\\_0.pdf](http://www.fern.org/sites/fern.org/files/FERN_review_forestry_strategy_110908_0.pdf) (accessed 20 December 2018).
- FERN, 2018. Fern's analysis of the agreement on a new EU Renewable Energy Directive for the period after 2020. <https://fern.org/sites/default/files/news-pdf/Fern%20Analysis%20of%20REDII.pdf> (accessed 20 December 2018).
- IEA Bioenergy, 2018. European Union – 2018 update: Country Reports. [https://www.ieabioenergy.com/wp-content/uploads/2018/10/CountryReport2018\\_EU\\_final.pdf](https://www.ieabioenergy.com/wp-content/uploads/2018/10/CountryReport2018_EU_final.pdf) (accessed 15 November 2018).
- ICCT, 2018. Final recast renewable energy directive for 2021–2030 in the European Union: policy update. [https://www.theicct.org/sites/default/files/publications/EU\\_Fuels\\_Policy\\_Update\\_20180719.pdf](https://www.theicct.org/sites/default/files/publications/EU_Fuels_Policy_Update_20180719.pdf) (accessed 15 November 2018).
- Irvin, R. A., Stansbury, J., 2004. Citizen participation in decision making: Is it worth the effort? *Publ. Admin. Rev.* 64, 1: 55–65.
- Jordan, A., 1999. The implementation of EU environmental policy: a policy problem without a political solution? *Environ. Plann. C Gov. Policy*, 17, 1: 69–90.
- Jordan, A., 2000. The politics of multilevel environmental governance: subsidiarity and environmental policy in the European Union. *Environ. Plan. A*, 32, 7: 1307–1324.
- Julien, B., Lammertz, M., Barbier, J. M., Jen, S., Ballesteros, M., de Bovis, C., Krott, M., 2000. VOicing Interests and ConcErns: NATURA 2000: an ecological network in conflict with people. *Forest Policy and Economics*, 1, 3/4: 357–366.
- Lindstad, B. H., Pistorius, T., Ferranti, F., Dominguez, G., Gorriz-Mifsud, E., Kurttila, M., Leban, V., Navarro, P., Peters, D. M., Pezdevšek Malovrh, S., Prokofieva, I., Schuck, A., Solberg B., Viiri, H., Zadnik Stirn, L., Krč, I. 2015. Forest-based bioenergy policies in five European countries: An explorative study of interactions with national and EU policies. *Biomass and Bioenergy*, 80: 102–113.
- Majone, G., 1999. The regulatory state and its legitimacy problems. *West Eur. Polit.*, 22, 1: 1–24.
- Mantau, U., Saal, U., Prins, K., Steierer, F., Lindner, M., Verkerk, H., Eggers, J., Leek, N., Oldenburger, J., Asikainen, A., Anttila, P., 2010. EUwood – Real potential for changes in growth and use of EU forests. Final report. Hamburg/Germany: p. 160.
- Matthews, R., Hogan, G., Mackie, E., 2018. Carbon impacts of biomass consumed in the EU: Supplementary analysis and interpretation for the European Climate Foundation. Project report for ECF. Forest Research: p. 61.

- Peters, D., Wirth, K., Böhr, B., Ferranti, F., Górriz-Mifsud, E., Kärkkäinen, L., Krč, J., Kurttila, M., Leban, V., Lindstad, B. H., Pezdevšek Malovrh, Š., Pistorius, P., Rhodius, R., Solberg, B., Zadnik Stirn, L., 2015. Wood energy from forests— stakeholder perceptions in five European countries. *Energy, Sustainability and Society*, 5, 17: 1–12.
- Pezdevšek Malovrh, S., Kurttila, M., Hujala, T., Kärkkäinen, L., Leban, V., Lindstad, B. H., Peters, D. M., Rhodius, R., Solberg, B., Wirth, K., Zadnik Stirn, L., Krč, J., 2016. Decision support framework for evaluating the operational environment of forest bioenergy production and use: Case of four European countries. *Journal of Environmental Management*, 180: 68–81.
- Searchinger, T. D., Beringer, T., Holtsmark, B., Kammen, D. M., Lambin, E. F., Lucht, W., Raven, P., van Ypersele, J.-P., 2018. Europe’s Renewable Energy Directive Poised to Harm Global Forests. *Nature Communications* 9, 1: 3741.
- Schulze, E. D., Körner, C., Law, B. E., Haberl, H., Luyssaert, S., 2012. Large-scale bioenergy from additional harvest of forest biomass is neither sustainable nor greenhouse gas neutral. *Glob. Change Biol. Bioenergy* 4, 6: 611–616.
- Schyns, J. F., Vanham, D., 2019. The Water Footprint of Wood for Energy Consumed in the European Union. *Water*, 11, 2: p. 11.
- Stupak, I., Asikainen, A., Jonsell, M., Karlton, E., Lunnan, A., Mizaraité, D., Pasanen, K., Pärn, H., Raulund-Rasmussen, K., Röser, D., Schroeder, M., Varnagiryte, I., Vilkryste, L., Callese, I., Clarke, N., Gaitnieks, T., Ingerslev, M., Mandre, M., Ozolincius, R., Saarsalmi, A., Armolaitis, K., Helmisaari, H.-S., Indriksons, A., Kairiukstis, L., Katzensteiner, K., Kukkola, M., Ots, K., Ravn, H. P., Tamminen, P., 2007. Sustainable utilisation of forest biomass for energy—Possibilities and problems: Policy, legislation, certification, and recommendations and guidelines in the Nordic, Baltic, and other European countries. *Biomass and Bioenergy*, 31, 10: 666–684.
- Wolfslehner, B., Krajter, S., Jović, D., Nestorovski, L., Velichkov, I., 2009. Framing stakeholder and policy issues for coppice forestry in selected Central and South-Eastern European countries. *Silva Balcanica*, 10, 1: 21–34.
- WWF European policy Office, 2018. EU biomass rules could ‘increase emissions’, say advisors to European Commission. <http://www.wwf.eu/?uNewsID=328493> (accessed 20 December 2018).