# Impact of bioenergy on regionalized nitrogen balances

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Results of regionalized and overall net-N-balances are used to fulfil different reporting obligations, as well as input data for nitrate leaching modelling (Bach et al. 2014). For Germany, these regionalized net-N-balances are calculated for 402 administrative units on the NUTS-III-level (Landkreise and kreisfreie Städte in Germany), 16 administrative units on the NUTS-I-level (Bundesländer in Germany) and the whole country for every year from 1995 to 2015. The so far existing net-N-balancing method includes nitrogen inputs and outputs of crop production and animal husbandry, however, not the utilization of crops and farmyard manure for energy production (Bach et al. 2014).

Due to the introduction of guaranteed feed in tariffs for electricity production from biomass by the German renewable energy law in 2000 and the introduction of more favourable conditions for electricity production from biogas in 2004 (EEG 2000, EEG 2004) in the frame of the German policy of energy transition towards renewable energies („Energiewende"), the electric capacity of biogas plants had a steep increase in the years afterwards, the installed electric capacity increased from 149 MW in 2004 to 5080 MW in 2015 (BMWi and AGEE Stat 2016). The cropping area for the production of energy cops for biogas production increased as well from 0.4 Mio ha in 2007 to 1.393 Mio ha in 2015 (Statista 2017). We introduced a method to calculate the nitrogen input via energy crops, farmyard manure and organic waste, output via biogas digestates and gaseous nitrogen losses via $NH_3$, $N_2O$, $NO_x$ and $N_2$ during the anaerobic digestion, digestate storage and spreading on the field, the emission factors for these nitrogen species are obtained from the report on methods and data for the agricultural part of the German national greenhouse gas inventory and informative inventory report (Haenel et al. 2016). To obtain highly resolved information on the distribution and capacity of biogas plants on NUTS-III-level, we use a dataset which is kept and regularly updated by the Germany Federal Network Agency („Bundesnetzagentur") (Bundesnetzagentur 2016). These dataset does not include information about substrate input and therefore need to be intersect with regionalized substrate input data (DBFZ 2012), and to obtain nitrogen input quantities with the nitrogen content of these substrates (KTBL 2016).

Without including bioenergy production, the linear trend of the net-N-surplus in 2003 to 2014 for Germany is $-1.66x + 71.25$ kg N (ha LF a)$^{-1}$? , therefore, an overall decrease of the net-N-surplus of 18.3 kg N ha LF$^{-1}$ within 11 years was calculated. No such decrease was calculated, when biogas production was included into the net-N-balance.