

# NATIONAL AND REGIONAL ECONOMIC IMPACTS OF ELECTRICITY PRODUCTION FROM ENERGY CROPS IN THE NETHERLANDS

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**ABSTRACT:** Besides the known environmental benefits, national and regional economic impacts may form additional arguments for stimulating government measures in favour of electricity production from energy crops in the Netherlands. Therefore, we compared the economic impacts (at both national and regional level) of heat and power generation from energy crops (willow) and from imported natural gas in the Netherlands. Both conversion systems used combined cycle technology (30 MW electric and 30 MW thermal capacity). Input-Output Analysis was used to calculate indirect impacts.

It is concluded that, for the case under consideration, generating electricity from willow, compared to using natural gas, gives a higher contribution to the Gross Domestic Product (both nationally and regionally) and creates more employment if willow is produced at obligatory set-aside agricultural areas (in the chosen region in the Netherlands). However, when grain production is substituted by willow, the renewable system results in smaller effects on the economy than the fossil alternative.

## 1. BACKGROUND

Using energy crops for electricity production may have a more positive impact on the national and regional (provincial) economy than conventional, fossil fuel based, technologies. If this is the case, it could form an additional argument -besides the known environmental benefits [1, 2] - in favour of supportive and stimulating measures by the government for this type of renewable energy.

This positive effect on the economy can be expected since energy crops can be produced domestically while fossil fuels are largely imported in the Netherlands. Increased domestic production results in a larger contribution to the Gross Domestic Product (GDP) and local employment.

The aim of this research is to compare power generation from fossil fuels and energy crops on the basis of their contribution to the GDP, the employment creation and their impact on the financial deficit of the government, both on a national and on a regional basis.

## 2. METHODOLOGY

### 2.1. General methodology

A literature study of potentially suitable calculation methods was performed, resulting in the choice of the most suitable method, based on previously defined criteria. The chosen

calculation method was modified in such a way that it allowed incorporation of the characteristics of this specific study. Subsequently, a case study was defined for the two systems to be compared. The economic impacts of the energy crop electricity system and the alternative fossil system were calculated using the developed calculation method.

### 2.2. Method to calculate macro-economic impacts

Three potential calculation methods were studied, that have been found suitable for calculating macro economic effects, i.e. Cost-Benefit Analysis (CBA), Input-Output Analysis (IO) and Social Accounting Method (SAM) [3]. A literature study was performed and the methods were judged by previously defined criteria (Table I).

The results from the methodological comparison were that Input-Output Analysis is the most suitable method for this research for the following reasons:

- Dutch Social Accounting Matrices are not available at a regional/provincial level for the chosen region while regional assessment is possible in both other methods.
- Cost-Benefit Analysis only hands instruments to calculate the direct effects of a project while Input-Output Analysis also assesses the indirect effects that occur in the total supply chain of the products necessary in the system. This results in a more comprehensive study of the impacts on the economy.

Table I: Results from method comparison on the criteria displayed in the heads of the columns in a decreasing order of importance

Method	Regional Assessment	Meeting data and software requirements	Measuring economic effects	Adjusting method to specific charact. of case study	Dealing with market distortions
CBA	Possible	Possible	Direct	Possible	All
IO	Possible	Possible	Direct and Indirect	Possible	Partly
SAM	Not Possible	Possible	Direct, Indirect and Induced	Possible	Partly

### 2.3. Input-Output Analysis (IO)

The main component of this method is the IO-table of the Dutch economy, stating the monetary value of the annual intermediate expenditures between the various productive sectors, the import and the value added needed by them and the final demand for their products [4]. The original table describes the current situation, in which mainly fossil fuels are used for electricity and heat production. This table is transformed into a second table, describing the estimated production structure when electricity and heat are partly produced by gasifying energy crops.

After defining the characteristics of the renewable and fossil energy systems and gathering the necessary data, the cost components of both types of electricity were calculated.

These components can be split up into (1) value added (e.g. wages, profit, land rent, taxes-subsidies etc.), (2) intermediate expenditures in the productive sector of the economy and (3) imports (see "round 1" in Figure 1.) The intermediate expenditures at its turn can be subdivided in the same three components and so on (see "round 2" and further in Figure 1). Finally, we see that the cost price can be divided in (direct and indirect) import and (direct and indirect) value added. Because the total amount of value added in a country sums up to the GDP, the share of value added in the cost price can be used as a criterion for the contribution of this product to the GDP.

With the IO table, the steps from the left to right side of Figure 1 can be performed by a relatively simple matrix calculation.

### 2.4. Correction of results

The difference in cost price in the two systems is assumed to be compensated by a government subsidy, in order to make sales possible in a competitive market. The calculated value added in the energy crop system should be corrected for this subsidy, since these funds are only transferred from government accounts to the industries and do not create additional GDP. The final comparison of the economic effects of the fossil system and the energy crop system is based on this corrected impact.

### 3. DEFINITION OF THE CASE STUDY

Table II shows the main parameters of the selected case.

- Willow has been selected as the short rotation crop in this research because of its good performance and the large experience which is already available with this crop in Europe.
- Two types of agricultural land-use are assumed to be substituted by willow production: grain production and obligatory set-aside land. If Dutch grain production is substituted by energy crops, more grain will have to be imported.
- Region: due to the relatively high proportion of grain production in the cropping plan and the relatively large area of set-aside land, the region Oldambt in the northern province of Groningen is the most suitable region for willow production, from an economic point of view. However, this will be highly influenced by future EU agricultural policy.
- The biomass gasification combined cycle technology (BIG/CC) is chosen since it is a promising technology with a high efficiency [5]. For the natural gas system we also chose a combined cycle plant. Both systems are assumed to generate both heat and power.
- The natural gas is assumed to be imported to keep the Dutch gas supply equal in the renewable and fossil cases. Otherwise, when using domestic national gas, the economic value of the larger domestic gas reserve would have to be calculated in the energy crop system.

Table II: Definition of Energy Systems

Parameter	Energy crops	Fossil fuel
Fuel type	willow	natural gas
Fuel region	Oldambt (Groningen)	import
Replaced land-use	set-aside / grain	-
Technology	BIG/CC-CHP	GICC/CHP
Capacity	30 MW <sub>cs</sub> , 30 MW <sub>th</sub>	

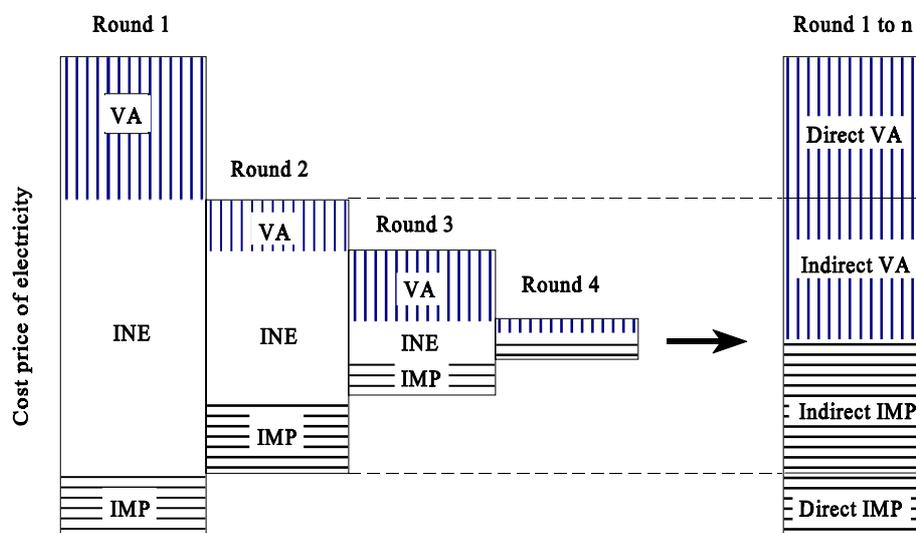


Figure 1. The division of the cost price in import (IMP), intermediate expenditures (INE) and value added (VA).

#### 4. RESULTS OF THE CASE STUDY

Figures 2 and 3 show the results for the set-aside and grain replacement cases respectively. The bars on the left side divide -for both energy systems- the cost price of electricity and heat (and grain in Figure 3) into value added and import (before correction for the government subsidy). The bars on the right represent these shares after correction for the shift of money from government to industries due to the cost price subsidy.

From Figure 2 it can be observed that the corrected value added in the energy crop system is larger than in the fossil system for the set-aside replacement case.

Figure 3 shows that the value added created by grain production is relatively large. The value added of the combination of electricity and heat from natural gas and national grain production is larger than the value added in the case of electricity and heat production from nationally

produced energy crops in combination with grain imports. For the region of Groningen, the value added is slightly higher in the energy crop case, resulting from the fact that the government cost price subsidy will be paid by the inhabitants of the whole of the Netherlands through tax payments, while the province of Groningen receives relatively more economic benefit from the necessary energy crop subsidy (Table III). In the energy crop system more employment is created at national and regional level than in the natural gas system, if the set-aside lands are utilised (Table III). This table, however, also shows that when grain production is substituted by willow production, the loss of working hours of local farmers is large, resulting in a negative effect on national and regional employment (for more details: [6]) The government financial deficit increases by choosing the energy crop system due to the necessity of the assumed cost price subsidy.

Table III: The **difference** between the economic impact in the energy crop and the fossil system (meaning: the effects in the energy crop system minus the effects in the fossil system) for two types of land-use replacement, at the national and regional level, when electricity and heat is produced in a 30 MW plant.

		Set-aside replacement			Replacement of grain production		
		National	Groningen	Rest of NL	National	Groningen	Rest of NL
Difference in value added	[10 <sup>6</sup> Dfl/yr]	8	17	-9	-14	4	-18
Difference in employment	[job <sub>equivalent</sub> /yr]	123	80	43	-3	-16	13
Diff. in government fin. balance <sup>a</sup>	[10 <sup>6</sup> Dfl/yr]	-13			-20		

<sup>a</sup>The difference in Government Financial Deficit is only presented for the purpose of illustration; this number is already taken into account in the 'difference in Value Added'.

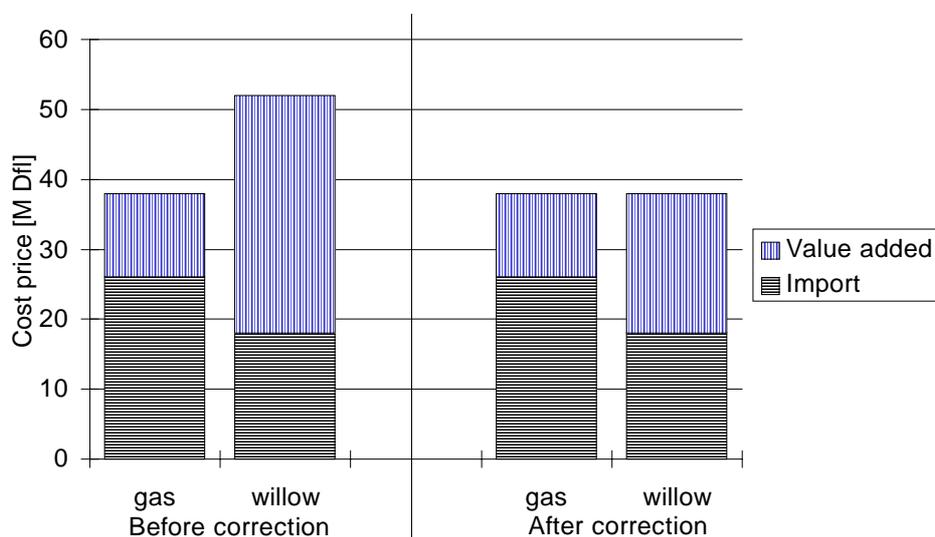


Figure 2. The share of value added and import in the cost price of the energy crop and natural gas system in the case of replacement of set-aside land, before and after correction for the cost price subsidy

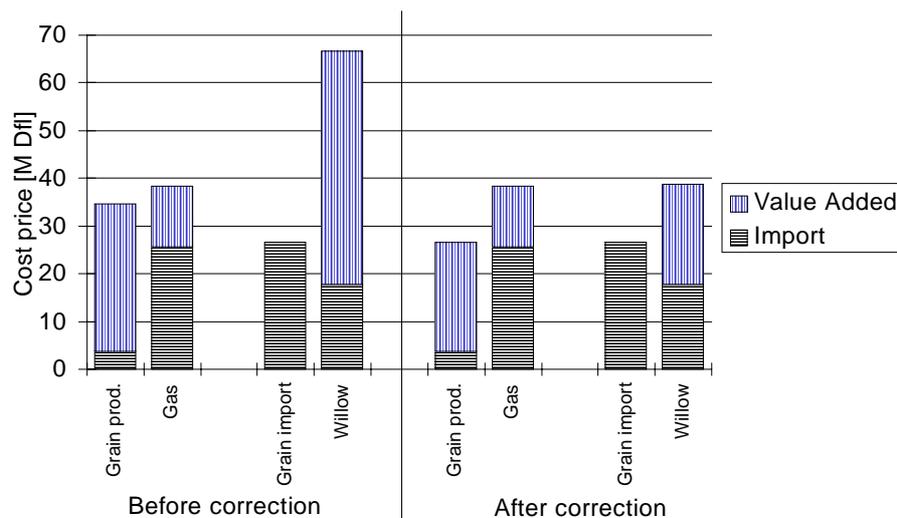


Figure 3. The share of value added and import in the cost price of grain production and power generation from natural gas on the one hand and grain import and power generation from energy crops on the other, before and after correction for the grain premium and the cost price subsidy on the energy crop system.

## 5. CONCLUSION

When **set-aside land** is available to be replaced by willow production, the total value added of the country and province of Groningen is higher when energy crops are used instead of imported natural gas to generate heat and power. Thus, in spite of the necessary subsidy in the case of energy crops, the contribution of this biomass energy system to the GDP is superior to the one in the natural gas system. For the government as an economic actor, the biomass case does implicate a higher financial deficit.

However, when the production of willows **substitutes grain production** the national economy benefits more from choosing the fossil option. The value added in the province is slightly higher with the energy crop option, but the employment situation in Groningen does not benefit from switching from grain production and the use of natural gas to the production and use of energy crops.

It can be concluded that -under the assumptions made- in the case of energy crop production on previously set-aside land, beside the already existing environmental advantages, biomass electricity also creates advantages for the national and regional economy. This could be an additional argument in favour of government intervention to increase the competitiveness of this type of power generation.

## 6. DISCUSSION

- Due to the choice of gasification technology, calculations about a future situation were made. This resulted in many assumptions. Especially the yield of willow per hectare and the future price of natural gas influence the calculated economic impacts. This is, however, not likely to influence the preference between the two systems from a macro-economic point of view.
- It is not expected that in reality direct government subsidies will be used to compensate the higher costs of renewable energy. A whole spectrum of policy measures

are available for this purpose [7]. This, however, only results in a shift of money between the various national economic actors, with low impact on the value added calculations [6].

- The results are only valid for the presented case definition. Considering other technologies with different investment costs, may change the results.
- As a methodology to assess the contribution to the GDP, IO analysis has quite some shortcomings, an overview of which has been given by Vlasblom [6].

## 7. REFERENCES

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