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Renewable energy resources in the SEEA Issue paper

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1. Introduction

More and more, the subject of renewable energy receives public attention. The debate on renewable energy is fostered by the fact that fossil fuels are becoming scarce and that their combustion produces CO_2 which contributes to climate change (IPCC, 2007). Renewable energy is a substitute for non-renewable energy. Renewable energy can be produced in many different ways, i.e. wind energy, hydropower energy, solar energy, geothermal energy and so on. These energy transformation technologies are considered more environmentally friendly than conventional, fossil sources based transformation technologies. For example, they go along with fewer emissions to air than their fossil counterparts which are based on the combustion of fossil fuels. Secondly, these alternative technologies consume no or less fossil energy and thereby preserve existing national and international fossil energy reserves.

The problems related to scarcity of fossil fuels are expected to become more severe over time, especially for countries which are highly dependent on non-renewable energy resources. In a reaction to this, governments are trying to develop and install policies to reduce air emissions and to reduce fossil energy depletion. A lot of countries are in the process of transforming their energy policy to a more sustainable one.

In the System of National Accounts, fossil energy resources are recorded as non produced assets in the national balance sheet. In order to comply with the general definition of an economic asset, natural assets must not only be owned, but must also be capable of bringing economic benefits to their owners, given the technology, scientific knowledge, economic infrastructure, available resources and set of relative prices prevailing on the dates to which the balance sheet relates or expected to do so in the near future (SNA 2008, §10168). These requirements are generally met for fossil energy resources like coal, natural gas and oil. As a logical consequence, an increasing number of countries publish statistics on the public and private ownership of fossil natural energy deposits.

So far renewable natural energy resources are, however, not generally recorded as assets on the national balance sheet. This seems to be a serious omission since their share in total energy production is increasing. Fostering the exploitation of renewable energy resources is undoubtedly an important part of sustainable development policy strategies around the world. Balance sheets that are restricted to non-renewable energy resources only could lead to a serious underestimation of a country’s available energy resources. The key research question to be answered in this issue paper is whether the various renewable energy resource categories can be meaningfully identified as independent assets according to the SNA and SEEA asset boundaries. In this regard, there is a range of conceptual issues related to the accounting of renewable energy resources that need to be solved, namely:

- What is the nature of the asset service (as energy source) provided by e.g. water, solar radiation and wind?
- Do ownership and direct benefits to the owner exist?
- If renewable energy asset values are the result of government regulation of energy prices, should these values be included in the net worth of an economy?
- Can we meaningfully distinct (A) fixed assets and (B) non produced assets (the renewable energy resource) in the balance sheet of renewable energy producers?
- Under which conditions does exploitation of renewable energy resources coincide with resource rents and depletion?

In section 2 these conceptual questions are being discussed. This discussion also addresses the possible consequences of economic instruments regulating energy production and consumption on resource rent calculations. Section 3 provides an accounting scheme for determining the resource rent of renewable energy assets. Finally, in section 4 tentative numerical results are being presented for the Netherlands (wind energy) and Norway (hydro energy). Section 5 winds up with a complete the list of questions for discussion as posed in this issue paper.

2.1 Assets in the SNA and in the SEEA

SNA 2008 and SEEA-2003 definitions of assets

Assets as defined in the SNA 2008 are entities that must be owned by some unit, or units, and from which *economic benefits* are derived by their *owner(s)* by holding or using them over a period of time. The ownership criterion is important for determining which natural resources are treated as assets in the SNA. Natural resources such as land, mineral deposits, uncultivated forests or other vegetation and wild animals are included in the balance sheets provided that *institutional units are exercising effective ownership rights over them, that is, are actually in a position to be able to benefit from them*. Assets need not be privately owned and could be owned by government units exercising ownership rights on behalf of entire communities. Natural resources such as the *atmosphere* or *high seas*, over which no ownership rights can be exercised or mineral and energy reserves that have not been discovered or that are unworkable are not included as they are not capable of bringing any benefits to their owners, given the technology and relative prices existing at the time (SNA 2008, §1.46).

It is clear that the SNA definition of assets leads to the exclusion of the natural energy resources ‘atmosphere’ (hereafter called wind) and solar. Although there are clearly economic benefits derived from using wind to produce electricity, there are no formal ownership rights enforced by the users of this kinetic energy form. Wind energy and solar power are renewable energy forms which are infinite and the use of wind and solar energy does not affect other (potential) users of this energy source directly.

In the SNA definition *water resources consist of surface and groundwater resources used for extraction to the extent that their scarcity leads to the enforcement of ownership or use rights, market valuation and some measure of economic control.* (SNA 2008, §10.184). Water resources are included in the balance sheet to the extent that they have been recognized as having economic value that is not included in the value of the associated land (SNA 2008, §13.51). Resource ownership rights are generally established in the case of hydropower. The electricity producer usually has the (exclusive) right to use water for energy purposes and can therefore be identified as the economic owner.

The SNA definition is only partly in line with the SEEAW asset boundary of water resources which is very broad and includes, in principle, all inland water bodies, namely surface water (rivers, lakes, artificial reservoirs, glaciers, snow and ice), groundwater and soil water. In particular, in the case of water, the SNA defines water resources within its asset boundary as “aquifers and other groundwater resources to the extent that their scarcity leads to the enforcement of ownership and/or use of rights, market valuation and some measure of economic control”. Thus only a small portion of the total water resources in a country is included in the SNA (SEEAW, §2.39-2.40). The SEEAW extends the SNA boundary to include all water resources that provide direct use and non-use benefits. This implies that the SEEA-2003 asset category “water resources” (classified in the category EA.13) includes all the water resources from which water can be extracted in the current period as well as other resources which may be extracted in the future (SEEAW, §6.11).

Surface water comprises all water that flows over or is stored on the ground surface (UNESCO/WMO International Glossary of Hydrology, 1992). Surface water includes *artificial reservoirs,* which are man-made reservoirs used for storage, regulation and control of water resources (SEEAW, §6.15). Most water resources are non-produced assets, that is, they are “non-financial assets that come into existence other than through processes of production”. It could be argued, however, that water contained in artificial reservoirs comes into existence through a production process: a dam has to be built, and, once the dam is in place, activities of operation and management of the dam that regulate the stock level of the water have to be exercised on a continuous and regular basis (SEEAW, -§6.23)

In the SNA, an asset, even an environmental asset, is defined in terms of the benefit limited to the provision of income or a stock of wealth which can be converted to monetary terms. For the SEEA, the concept of an environmental asset is linked to the provision of environmental functions. This extension is predicated on the notion of an environmental function. The environment is defined as the naturally produced physical surroundings on which humanity is entirely dependent in all its activities. The various uses to which these surroundings are put for economic ends are called environmental functions. When the use of one function is at the expense of the same or another function now, *or is expected to be so in the future*, there is competition of functions (SEEA, §7.30 and §7.31).

Competing environmental functions mean that the environmental elements which provide the functions translate into economic entities. They are scarce in that more of one entails less of the other. *A sacrifice has to be made of some of the competing functions and thus opportunity costs are necessarily involved in making the trade-off of between functions* (SEEA, §7.32). The functions provided by the environment yield a benefit to the economy. Whichever of the three types (spatial, quantitative, and qualitative) of function is considered, the economy benefits from the use made of the environmental functions. One way to extend the SNA asset boundary is thus to express the benefits yielded by environmental assets in terms of the uses made of them. Direct use benefits include the use of environmental assets as sources of materials, energy or space for input into human activities. Indirect use benefits do not change the physical characteristics of the environment and are sometimes described as being non-consumptive. The amenity benefit of landscape is one example (SEEA, §7.35 until §7.37).

Renewable energy resources: checking the SNA and SEEA definitions

Water

The construction of river dams for hydro energy production seems to imply that ownership of the water collected in the concomitant artificial lakes are allocated to the owner of the hydro energy plant. The owner will usually collect the economic revenues to be derived from these artificial lakes. Therefore, these lakes seem to comply with the general SNA definition of assets. A subsequent question that needs to be answered is whether the (asset) value of the lake can be determined independently from the infrastructure, i.e. the dam.

Water is a resource which use may affect consumption possibilities of other economic agents directly. The production of hydropower usually requires the building of dams and the creation of artificial water basins. This may reduce the downstream water flows of rivers. Hydropower production may therefore negatively affect use options downstream such as water for other energy production, agriculture or drink water supply. One environmental function of water (energy transformation) competes directly with other functions. This means that also the SEEA boundary of assets principally includes hydropower reservoirs.

Wind and solar power

On the other hand, electricity production on the basis of wind or solar energy does not seem to lead to ownership of these energy resources. Also wind power does not seem to prevent other use options. It does not affect future consumption options in the way the consumption of fossil resources does. Also, one wind turbine does not really seem to affect the productivity of other wind turbines (perhaps only in the very close neighbourhood). In other words, there seems to be no direct competition between the uses of wind for energy production. This feature implies that opportunity costs related to the use of wind for energy production do not exist. The same kinds of arguments hold for the use of solar energy. On the basis of these arguments one may conclude that wind en solar energy fall outside the asset boundaries of both SNA and SEEA.

Externalities

The exploitation of renewable energy sources may coincide with negative (and positive) externalities. For example, wind turbines can cause noice nuisance, bird losses and visual disturbances of landscapes. In this context there is certainly an issue of competition between environmental functions. However, this issue is not so much related to the (renewable) energy resource itself, i.e. wind and solar energy, but much more a competition issue regarding the concomitant occupation and use of space. In this regard the exploitation of renewable energy resources does not differ in nature from the exploitation of any other natural resource which may equally lead to external effects. For example, oil platforms at sea may also lead to environmental disturbances in the direct neighbourhood of the platform.

So far, the SEEA does not seem to advocate that these externalities are reflected in the balance sheet values of natural resources. The measurement in terms of money valuation of externalities in general (of resource exploitation but equally any other economic production or consumption activity) is identified as a subsequent step in the accounts as discussed in chapters 9 and 10 of the SEEA-2003. Following the current SEEA structure of natural asset accounting, the discussion in this paper strictly focusses on the value of the (asset) function of the environment as the provider of renewable energy. It does not address the much broader discussion of declining ecological functions due to externalities created by renewable energy production.

Dependencies between renewable and non renewable energy asset values

Electricity is a homogenous good. As a logical consequence renewable and non-renewable electricity production technologies are in principle full substitutes. More renewable electricity production leads ceteris paribus to less fossil based electricity production. One may expect worldwide energy demand not to decline substantially in the coming years. This implies that increasing scarcity of fossil fuels over time will lead to rising electricity prices which will inevitably create an incentive for the development of alternative non fossil energy resources.

Government regulation (carbon taxes or carbon pollution permits) of fossil fuel consumption may equally lead to higher electricity prices. This government imposed scarcity of fossil energy consumption can lead to additional economic benefits for the producers of renewable energy. It may function as an (implicit) subsidy for renewable energy producers.

In other words, the (government imposed) scarcity of finite mineral energy resources, for example as a result of climate change policies, may (temporarily) create a surplus income for renewable energy producers. And this may increase the net present values of their businesses. Key question is whether this increase in value has anything to do with the long term value of the renewable energy resource (wind, water, solar radiation)? In this context it is relevant to notify that this surplus value is likely to be temporarily in nature. If this surplus income is high enough, it will obviously trigger other producers to move their technologies from fossil to renewable energy based. And this will in the end diminish this surplus income. This surplus income is likely to exist in periods in which economies transform their energy systems from fossil to renewable energy technologies.

Income but not an asset

If one strictly applies the definitions of assets, one may conclude that wind and solar power are both not assets in the SNA or SEEA sense. However, still surplus income can be created by using renewable technology instead of the non-renewable technology. This surplus income is either created due to environmental regulation (climate change) or increasing scarcity of mineral energy resources. Inputs like 'wind energy' and 'solar energy' are the key production factors on which the creation of this surplus income seems to depend. These inputs have features which result in absolute advantages over the alternative (i.e. fossil based energy supply). This leads to the dilemma that there seems to be no asset in the SEEA and SNA sense while there is a surplus income resulting from its use in production. Should we regard this surplus income as a capital service of wind or solar power?

Question 1 Does the London Group agree with the conclusions drawn in this paper that in principle artificial water reservoirs (as in the SEEA Water, EA1311) do comply, while wind and solar radiation do not comply, with the SNA and SEEA definitions of assets?

Or, alternatively, should the SEEA definition on assets be broadened to include water, wind and solar energy resources? If yes, how?

2.2 Split up of fixed assets and renewable energy assets

The production of renewable energy requires in most cases a substantial amount of gross fixed capital formation. There appears to be strong complementarity between produced assets and the renewable energy resource. This feature is not unique. Mining in general is often highly capital demanding. An important question that needs to be answered in the context of this paper is whether we can meaningfully distinguish in the balance sheet the value representing the renewable energy resource from the fixed assets needed to exploit this resource.

This topic has some similarity with the discussion on land improvements in the SNA revision. Two alternative treatments were discussed at the October 2003 meeting of the Canberra II Group on the Measurement of Non-financial Assets. One of these was to classify each unit of land as either produced or non-produced, depending on whether land improvements represented more than half the asset value or not. The second proposal was that each unit of land could be seen as composed of two parts, one produced (representing the written down value of land improvements) and the residual part which would continue to be treated as non-produced. The final outcome of this discussion was that the non-produced component of land should be valued at its present unimproved value. This implies that land improvements should be recorded in the balance sheet separately from the original land, thus as two separate assets. Any excess in the higher valuation of renewable energy facilities which cannot be explained by the new capital formation is recorded as economic appearance in the 'other changes in volume account'. (the comparison with land improvements is made here, SNA 2008, §12.21).

Comisari (2008) and Veldhuizen (2008) have shown how to split up the gross operating surplus of mining operations in a fixed capital services component and the resource rent of mineral assets. Similarly, in the case of renewable energy production, capital income may not only include the capital services of fixed assets but also a resource rent component. On the basis of this split up of capital income, separate asset values can be determined for both the fixed assets involved in renewable energy production and the renewable energy resource. The next section of this paper explores the possibilities to define the resource rent of renewable energy resources.

Question 2 Does the London Group agree that in principle it is desirable to have separate asset values for fixed assets required for renewable energy production and the renewable energy resource itself?

2.3 Defining the resource rent of renewable energy assets

The definition in the SEEA-2003 of resource rent in the context of renewable energy requires further examination of existing literature. The definition needs to be reviewed in the context of scarcity and finiteness of (renewable) energy resources as well as environmental regulation by government.

The term 'resource rent' in the context of scarcity and finiteness can be defined as follows:

The unit price of an extracted natural resource contains a resource rent reflecting the value of a marginal resource unit with respect to its future extraction (Hotelling, 1931). However, resource rents are not directly observable but instead are typically derived as the difference between total revenue generated from the extraction of natural resources less costs incurred during the extraction process including the cost of produced capital (which itself includes a return to produced capital) (Comisari, 2008).

Or, as stated more simply in SEEA-2003:

the value of capital service flows rendered by the natural resources, or their share in gross operating surplus, is the...resource rent (SEEA-2003, §7.167).

This SEEA definition does not provide any information on the nature of the resource rent like the Hotelling definition does. It only indicates that the gross operating surpluses of mining operations contain an income component that is related to the capital service flow of natural resources. Accordingly, the issue paper of Comisari (2008) points out that for industries using a mixture of produced and non-produced assets in production, it holds that gross operating surplus can be decomposed into consumption of fixed capital and net operating surplus. The net operating surplus can be further decomposed into a return to produced assets, a return to non-produced assets and a measure of depletion (the latter two when added together are called *resource rent*).

For renewable natural resources depletion is not necessarily an issue. In case of sustainable exploitation the resource rent equals fully a return to capital and is attributed to the owner of this non-produced asset (Bain, 2007). According to (Bain, 2007), the SNA is of the view that in case an asset used in production *is infinitely abundant (or infinitely renewable)*, any amount of use would not affect its value (which would be zero). Consequently, there is no decline in its current value during the accounting period as a result of its use in production and the entire value of the capital service flows generated from using such an asset in production is an income to the owner of the resource. Only in case current resource extraction has a negative impact on the natural resource's reproduction capacity, a depletion element comes into place in the owner's income account.

Three mechanisms for rent creation

Economic rent is obtained when the profit earned exceeds the opportunity costs of all input factors[1]. In modern economics the term differential rent or intra-marginal rent is used to indicate differences related to other production factors, while *resource rent is specifically reserved for the property income of natural resources*[2]. Rents can be generated by way of at least three different mechanisms:

Differential rent (Ricardian rent):

The theory of the Ricardian rent shows how extra profit is transformed into rent by equal quantities of capital being invested in combination with different land categories of unequal productivity. The land rent arises due to the greater relative productivity of definite individual capitals invested in a certain sphere of production, as compared with investments of capital, which are excluded from these exceptional an natural conditions favoring the productivity (Marx, 1909).

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[1]Source: website http://fisherieseconomics.googlepages.com/resourcerent

Hotelling rent:

The hotelling rent is the net return realized from the extraction of a natural resource under particular conditions of long-term market equilibrium. The Hotelling rent reflects the value of a marginal natural resource unit with respect to its future extraction. While Ricardian rents could be regarded as 'cross-sectional' in a sense that they value productivity differences between one resource category (e.g. land), Hotelling rents are of a inter-temporal nature.

Monopoly rent:

Due to natural or other kinds of barriers, access to natural resources could be restricted to only a limited number of parties. As a result they are able to exploit their monopoly power by supplying less than the social optimal level. This will create monopoly rents. It is not unthinkable that in many cases natural resource owners benefit from certain levels of monopoly power.

For the SEEA we need to determine, at least from a conceptual point of view, which categories rents fall under the definition of resource rent.

Questions 3 Do both Hotelling rents and Ricardian rents comply with the SEEA definition of a resource rent?

Do monopoly rents comply with the SEEA definition of a resource rent?

Do these answers give rise to changing the current SEEA-2003 definition of a resource rent?

Exploiting the endowments of countries

Electricity production in countries like Norway and Switzerland is dominated by hydropower. The Netherlands produces only very limited amounts of hydropower electricity. The mountainous landscapes of Norway and Switzerland make it feasible to utilize the power of gravity by the medium water. The flat landscape of the Netherlands is less advantageous in that respect. In Europe the price of electricity is increasingly determined by the European market. The relative cost-efficiency of hydropower energy production in Norway compared to other energy technologies or hydropower energy generation in other countries may lead to a surplus income. This income is connected to the high resource quality of Norwegian water bodies with respect to power generation opportunities. This high resource quality brings about a Ricardian type of rent and subsequently positive asset values of many water resources in Norway. When also ownership rights are well established, there seems to be a true renewable energy asset in the SEEA and SNA sense.

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[2] Source:http://en.wikipedia.org/w/index.php?title=Differential_and_Absolute_Ground_Rent&action=edit&section=1

Questions 4 If Ricardian rents are included as resource rents, represents any surplus income generated from hydropower a resource rent? If yes, represents hydropower a renewable energy asset?

Rents in the light of government intervention

Government regulation of fossil fuel consumption such as the introduction of carbon emission permits may (implicitly) subsidise the incomes of renewable energy producers. A rise in permit values (due to increasingly restrictive issuing schemes) may lead to higher electricity production costs and subsequently to rising electricity prices. However, for renewable energy producers this price increase may lead to higher profits. A key question in this regard is whether this income increase should translate into higher renewable energy resource rents, given that we agree that any surplus income represents a resource rent. In any case, these increasing revenues are likely to be temporary since they will stimulate electricity producers to shift from old, fossil based, to new, renewable based, electricity production technologies. However, within this period of transformation, fuel rising government policies are expected to lead to temporary higher resource rents of renewable energy resources which are in fact implicit subsidies. Other (direct) subsidies on production (D.39) receivable by renewable energy producers may have a similar upward effect on renewable energy resource rents in case these subsidies do not have any influence on electricity prices.

The government induced transformation process from non-renewable technologies to renewable technologies leads to temporary market disturbances which can be motivated by at least two important market failures: (1) negative externalities due to climate change and (2) the too fast depletion of energy resources. This government intervention may bring about a redistribution of generated income. During the period of transformation, renewable production technologies are rewarded in excess for producing in a more sustainable manner than the fossil based alternatives. In other words, they are rewarded by way of government intervention for contributing less to greenhouse gas emissions and the depletion of non-renewable energy resources. After the transition period the consequences of government intervention will simply disappear. At this stage in time fossil fuels have been largely substituted by renewable alternatives and renewable technologies will be rewarded only a normal return to fixed capital.

The rents created during the transformation process could be named ‘transformation rents’. One could argue that ‘transformation rents’ are closely related to Ricardian type of rents, with at least two important exceptions that (1) transformation rents are only temporary and (2) that these rents are the result of government intervention. In this way wind and solar power possibly may generate resource rents given that Ricardian rents comply with the SEEA definition of resource rents. As a result one may conclude that both wind and solar energy sources are renewable energy assets in the SEEA. Wind and solar based energy technologies may temporarily generate surplus incomes in periods of transformation. When the costs of consuming fossil fuels are artificially increased wind and solar energy may for the time being generate a positive factor income. This leads to the dilemma that they seem to be no assets in the SEEA and SNA sense while there may appear an income flow which is directly connected to the service of wind and solar radiation.

Questions 5 Is the existence of long lasting rents a criterion for assets or can temporary rents, for example as a result of government policies, also lead to the (temporary) existence of assets?

If yes, does this make wind and solar radiation assets in the SEEA framework?

Rents in the light of scarcity of substitute natural inputs

Renewable and non-renewable electricity production technologies are in principle full substitutes. More renewable electricity production leads ceteris paribus to less fossil based electricity production. One may expect worldwide energy demand not to decline in the coming years. This implies that increasing scarcity of fossil fuels over time will lead to rising electricity prices which will inevitably create an incentive for the development of alternative non fossil energy resources. It will also lead to abnormal rents above the normal rate of return for renewable energy producers. A price increase of gas or oil may lead to a price increase of the homogenous good electricity while the producers of renewable energy do not experience any change (or almost none) in production costs. Until the moment that only the slightest part of the electricity market is dominated by non-renewable technologies, price increases in fossil fuels will have its impact on rents for renewable producers. Once the transformation is completed, the rents created in the renewable energy sector will probably disappear. For this type of 'transformation rent' the same reasoning applies as above. In this case the temporary rent is not the result of government intervention but instead the consequence of a technological transformation process.

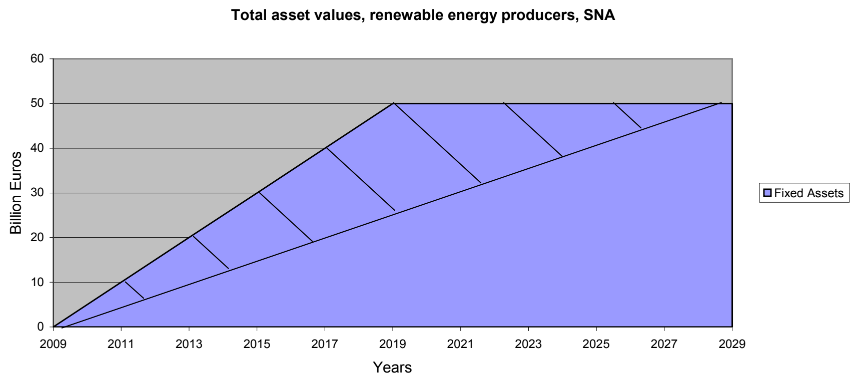
Questions 6 Are temporary surplus incomes that result from technological transformation processes resource rents?

If yes, does this make wind and solar radiation assets in the SEEA framework?

2.4 Balance sheets of renewable energy producers

The asset accounts (balance sheets) of SEEA should be able to indicate how natural versus fixed capital evolves overtime. This seems particularly important in periods in which countries transform there electricity supply from fossil to renewable techniques. This paragraph briefly illustrates the additional information the SEEA may be able to provide compared to the standard SNA balance sheets.

Let us suppose an economy which in one point in time, say 2009, completely depends on non-renewable energy sources for electricity production. Suppose also that the volume of electricity consumption is constant over time (we assume zero price elasticity). The government decides to ban fossil fuels and introduces a restrictive scheme of carbon emission permits. This leads to higher energy prices which create an incentive to introduce renewable energy technology alternatives.



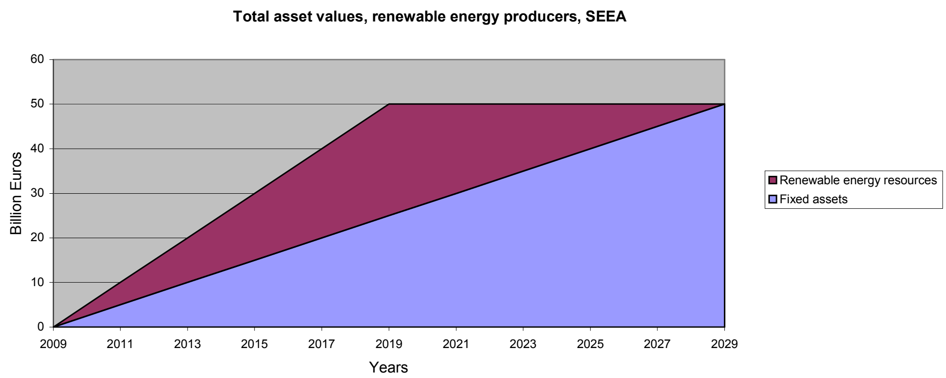


Figure 1 – Asset values of renewable energy producers

In the first stage of the transition period (2009-2019) resource rents of renewable energy resources increase as market shares of renewable energy producers rise. The upward effect of more strict environmental policy on electricity prices is larger than the downward effect on prices of more competition in the renewable energy sector.

In the second stage (2019-2029), when renewable electricity market shares become substantial, resource rents will decline. The production of renewable energy is still growing. The upward effect of more strict environmental policy on electricity prices is at this stage smaller than the downward effect on prices due to rising competition in the renewable energy sector. This will lead to declining resource rents over time.

As long as the electricity market is dominated by fossil based output, tighter environmental regulation will have its impact on the rents receivable by renewable producers. Once fossil energy technology has been fully abandoned, the effect of environmental regulation is phased out and the excess earnings of renewable energy producers will dry up.

In figure 1, this scenario is reflected in the SNA as well as the proposed SEEA framework. The SNA balance sheets only reflect the value of fixed assets and not that of renewable energy assets. In the SNA context there are at least two ways to look at the value of fixed assets. First, one may argue that the surplus income generated by renewable electricity production in the transition period has nothing to do with a return to capital. In this case the balance sheets simply indicate a linear increase in fixed asset stock values indicating the increase in renewable power plants over time.

A second option is to say that the surplus income is a temporary rise in the return to capital. This will lead to upward revaluations of fixed assets. One could say that by these revaluations the value of the renewable energy asset is encapsulated in value of fixed assets.

In case we would accept the (temporary) existence of renewable energy assets, the SEEA asset accounts will not undergo this SNA dilemma. The SEEA will explicitly reflect the value of renewable energy resources. In the SEEA accounts this surplus value is not allocated to fixed assets. The balance sheet positions of the latter fully correspond with the first SNA option.

3. Calculation of the resource rent of renewable energy assets

3.1 Concepts

This section discusses the actual calculation of resource rents and asset values of renewable energy assets. The methods correspond with those recommended for other natural resources in SEEA. According to the SNA any balance sheet item should be valued on the basis of representative market values. Such valuation relies on market prices for these items being available. Unfortunately, this valuation method is not broadly applicable to environmental resources as market price information is often not available.

SNA's next-best option to market price valuation is by calculating the net present value of current and future income streams derived from the asset in question. Like any other natural resource, renewable energy resources provide capital services to its owner and their remuneration should be an element in the gross operating surplus of the energy producer. This income element addressing the value of the renewable energy capital service is called the resource rent.

The first step in determining the resource rent is to determine the gross operating surplus of renewable electricity producers which is equal to value added minus compensation of employees minus taxes plus subsidies on production. In a subsequent step the consumption of fixed capital is subtracted together with a return to capital on fixed assets.

'Appropriation method'

In Norway calculations of resource rents[3] are based upon the collection of 'resource rent taxes' and concomitant tax rates in place. The resource rent is assumed to equal the resource rent taxes received divided by the tax rate. Data on received resource rent taxes may be a useful source in determining resource rents. However, full appropriation of resource rents by government does not always take place. Generally the SEEA should be able to provide information on the extent to which governments are able to collect resource rents. From this point of view, it is generally not recommendable from a policy use perspective to determine resource rents on the basis of the government appropriation method. However, in those countries where governments are able to fully collect the resource rents, the appropriation method is obviously a valid one.

3.2 Country examples

The calculation of the resource rent is based on the method presented in section 3.1. In the Netherlands resource rents for wind very much depend on the level of subsidies. This is partly caused by the fact that electricity prices have raised very sharply while subsidies per unit production were constant over time. In other words, the subsidy did not depend on the market price of electricity. The value of the renewable fixed assets (the wind turbines) is estimated at approximately 700 million euro. Consumption of fixed capital is approximately 70 million euro per year. In 2007, value added of renewable energy production was equal to approximately 190 million euro. The resource rent can be determined as follows:

Production value	257	
Intermediate consumption	− 68	
Value added	189	
Of which		
Subsidies (-)		− 294
Consumption of fixed capital		71
Return to fixed assets		50
Resource rent		362

Table 1-Determination of resource rent for wind turbines in the Netherlands, 2007

[3] In order to avoid confusion, the term 'ground rent', which is used in Norway, is replaced by resource rent.

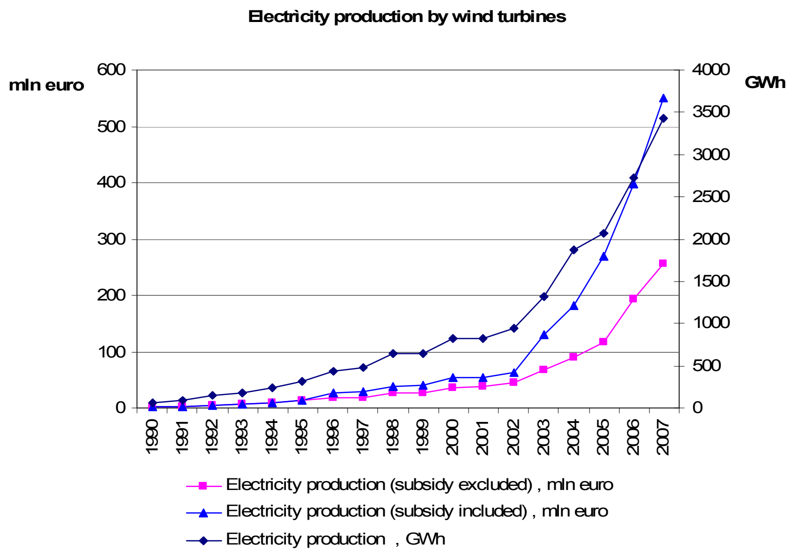


Figure 2-Production of electricity by wind energy, source: Statistics Netherlands, sustainable energy statistics[45]

In the Netherlands the production of renewable electricity increased substantially over the last 15 years. At the same time the market price for electricity increased due to the rising oil prices. And also subsidies on wind energy production increased as well. These three effects have contributed to the strong growth of wind energy production in the Netherlands. In 2007, the production value[6] of renewable energy production by wind turbines was estimated at 257 million euro (subsidies excluded).

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[4] Data on electricity production by wind turbines is available at the online databank of Statistics Netherlands: http://statline.cbs.nl/StatWeb/publication/?VW=T&DM=SLNL&PA=70789NED&D1=0&D2=2&D3=0-11,16,21,26,31,36,41,l&HD=090325-0935&HDR=T&STB=G1,G2

[5] Data on subsidies for half way 2003 up to 2007 refer to the main subsidy in these years, the MEP (Environmental Quality Electricity Production). The presented data were deduced by Statistics Netherlands from the micro data obtained from EnerQ, the body responsible for paying the subsidies to the owners of the wind turbines. Before 2003, information on REB (Regulating Energy Tax) has been used to estimate wind subsidies for the years 1997-2003. In this study, only subsidies on production are taken into ac count. Other subsidies, like investment tax deduction subsidies, are not taken into account.

[6] The employed pricing method is based upon the assumption that the basic price of all renewable electricity production is equal to the average electricity price. This is not completely in line with reality. Electricity from sources which are able to anticipate on demand acquires a higher price than electricity from sources which are supply tied. Most renewable options are supply-side driven facilities and are unable to anticipate on changes in demand in the short run. For example, the price for electricity from wind mills is probably lower than the standard price as they are "less reliable" to supply energy at every moment in time. More research is needed to specify price information dependent on whether the facility

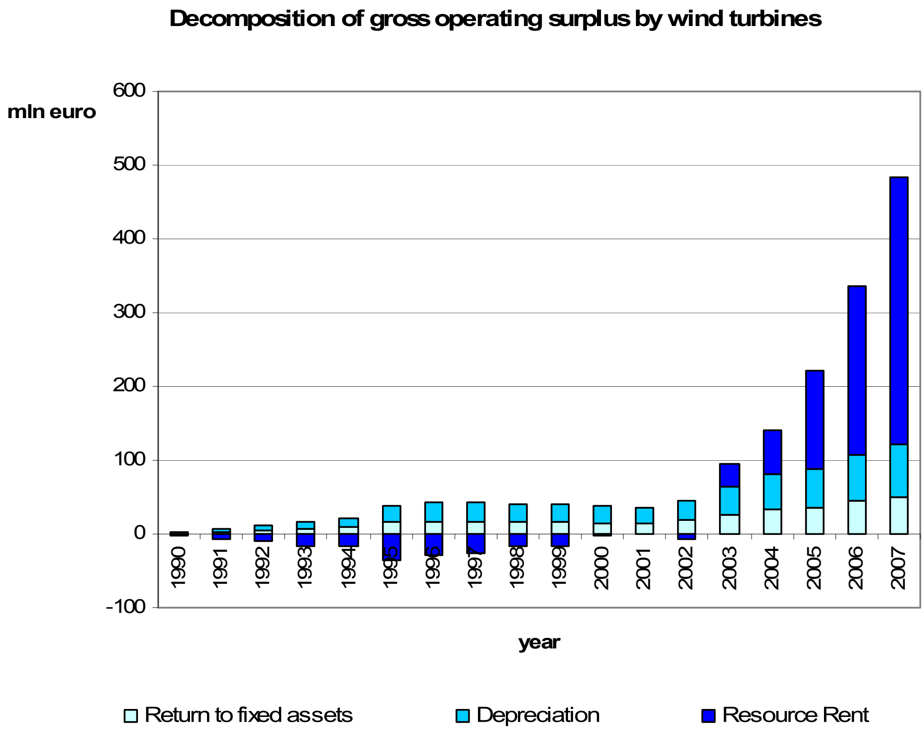
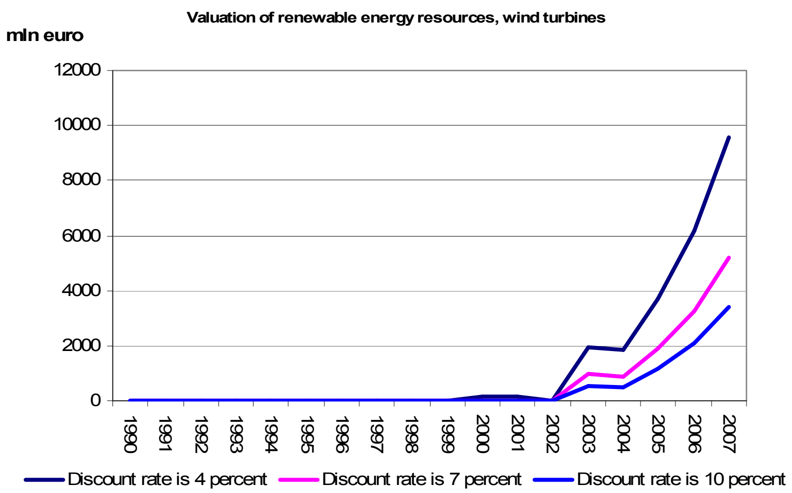


Figure 3- Decomposition of gross operating surplus of wind turbines

Gross operating surplus generated by wind energy producers has grown very fast over time. In figure 3 three components of GOS are being distinguished. While consumption of fixed capital and the return to fixed capital increased only slightly over time, growth of resource rent has been rather high. This is mainly caused by the price rise of electricity. In 2007, more than 75 percent of gross operating surplus (480 billion Euros in 2007) is attributed to the resource rent. In 2004, this ratio was only 35 percent.



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is demand-side driven or supply side driven. This remark should be carefully taken into account in interpretation the presented data.

Figure 4-Valuation of renewable energy resources, wind turbines

The value of renewable energy resources very much depend on the used discount rate. We used a discount rate of 7 percent. This rate is used for cost benefit analyses of renewable energy projects in the Netherlands. Figure 4 displays that wind energy in the Netherlands can be valued at approximately 5.1 billion euro in 2007. In 2003 this value amounted almost 500 million euro.

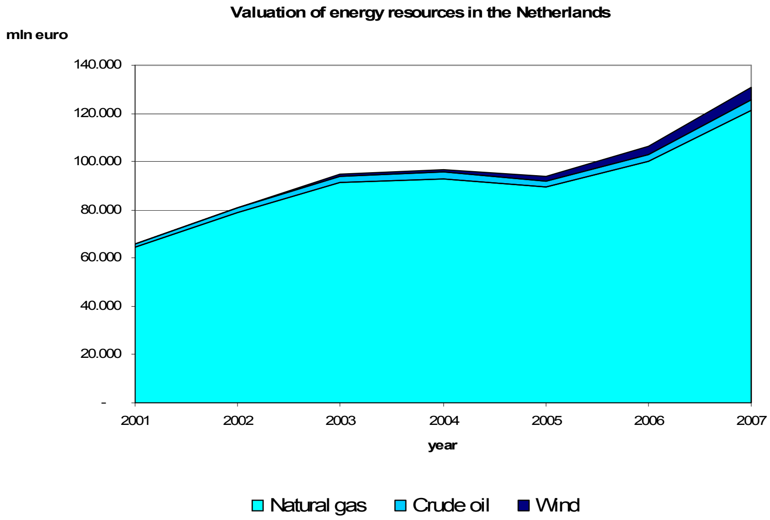

Figure 5-Valuation of energy resources in the Netherlands, wind turbines

The total picture of all energy resources in the Netherlands is displayed in figure 5. In 2007 wind energy wealth surpassed the total value of crude oil reserves in the Netherlands. The worth of natural gas reserves is still 20 times higher than that of wind energy resources (Statistics Netherlands, 2008). In the near future, the depletion of fossil energy reserves and the shift to renewable energy technologies will most likely bring about substantial changes in the total wealth represented by energy resources in the Netherlands. It seems quite relevant to monitor these changes by way of complete energy balance sheets in the SEEA including renewable energy resources.

3.3 Country examples: Hydropower in Norway

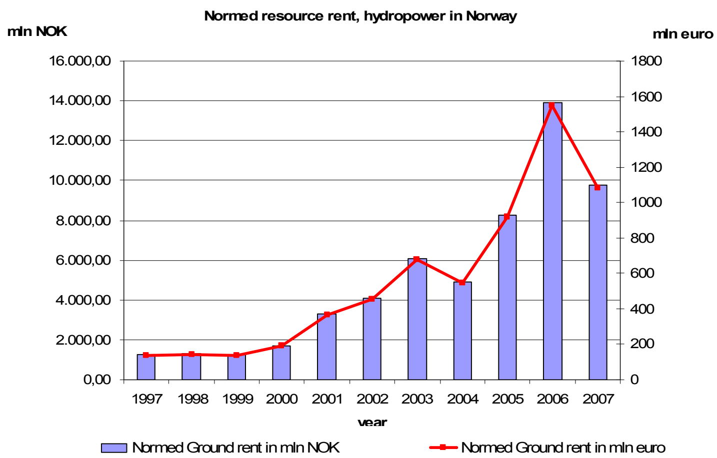

Figure 6- Normed resource rent[7,8] *hydropower in Norway, source: Statistics Norway*

The resource rent created via hydro-electric power stations in Norway is measured by Statistics Norway as the normalised sales value of electricity production minus operational cots, concession fees, property taxes, depreciation and a normal rate of return to capital. Generally, production value of renewable energy is derived by making use of spot market prices of electricity (for concessional power also some long term contracts have been used) and physical data on the production quantities of hydropower. The sharp increase in resource rents over the years is due to the deregulation of the electricity market and a sharp increase in demand.(note Torstein Bye, Statistics Norway). Using a discount rate of 7 percent, the value of water energy resources in Norway is equal to approximately 15 billion euro[9].

[7] Currency exchange rate used for NOK and euro is 9:1

[8] In order to avoid confusion, the term ‘ground rent’, which is used in Norway, is replaced by resource rent.

[9] Value is calculated by the authors of this issue paper based upon figures on rent of Statistics Norway.

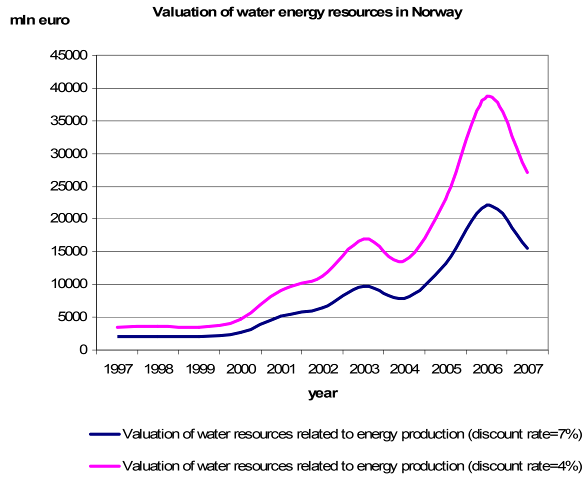

Figure 7- Valuation of water energy resources in Norway, source: revised data of Statistics Norway

5. Questions for the London Group

This section summarises the complete list of questions for discussion posed in this paper:

Question 1 Does the London Group agree with the conclusions drawn in this paper that in principle artificial water reservoirs (as in the SEEA Water, EA1311) do comply, while wind and solar radiation do not comply, with the SNA and SEEA definitions of assets?

Or, alternatively, should the SEEA definition on assets be broadened to include water, wind and solar energy resources? If yes, how?

Question 2 Does the London Group agree that in principle it is desirable to have separate asset values for fixed assets required for renewable energy production and the renewable energy resource itself?

Questions 3 Do both Hotelling rents and Ricardian rents comply with the SEEA definition of a resource rent?

Do monopoly rents comply with the SEEA definition of a resource rent?

Do these answers give rise to changing the current SEEA-2003 definition of a resource rent?

Questions 4 If Ricardian rents are included as resource rents, represents any surplus income generated from hydropower a resource rent? If yes, represents hydropower a renewable energy asset?

Questions 5 Is the existence of long lasting rents a criterion for assets or can temporary rents, for example as a result of government policies, also lead to the (temporary) existence of assets?

If yes, does this make wind and solar radiation assets in the SEEA framework?

Questions 6 Are temporary surplus incomes that result from technological transformation processes resource rents?

If yes, does this make wind and solar radiation assets in the SEEA framework?

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