Fossiilisen energian käytön vähenemisen vaikutus alkutuotannossa

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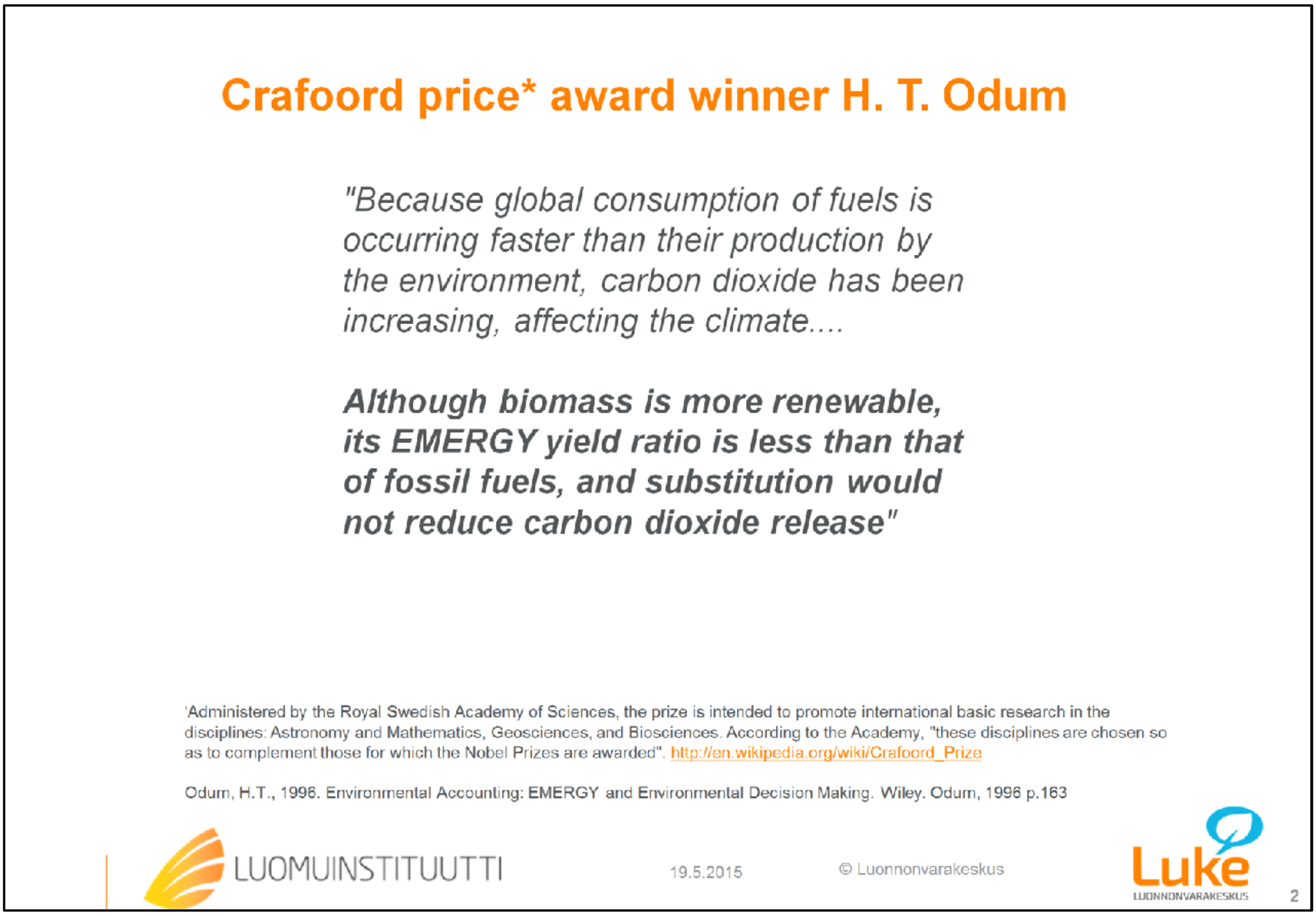
I am an Agricultural Engineer from Germany and I belong to the generation of researchers that experienced the so called oil crisis.

So I started my career in the eighties researching the same question as today:

How to substitute fossil fuels by renewable ones?



About 10 years ago I read in the book Environmental Accounting from the Crafoord price laureat Howard Odum:

"Because global consumption of fuels is occurring faster than their production by the environment, carbon dioxide has been increasing, affecting the climate....

Although biomass is more renewable, its EMERGY yield ratio is less than that of fossil fuels, and substitution would not reduce carbon dioxide release"

This statement of H.T. Odum and the fact that every year the IPCC-report confirms this statement led to the question: are now after 40 years research all our efforts to replace fossil energy by renewable ones in vain?

In 2013 I finished my presentation at a venue of the Energy Academy project about the energy consumption of the Finnish agriculture with following questions:

- Shall we reduce animal production?
  Because animal production is the greatest energy consumer
- Shall we replace chemical fertilisers by organic ones?
  Because recycling of manure – by the way primary target of organic farming since ever - is presently in vogue
- Shall we promote mixed farming?
  Because mixed farms lower the logistic problems caused by locating crop and animal production far from each other
- Shall we charge farmers with external cost?
  Because allocating cost of environmental pollution to producers may decrease use of fossil energy, see CO_2 certificates
- Shall we outsource agricultural production?
  Because outsourcing will be the cheapest way to fulfil the EU targets to reduce CO_2 emissions

The same questions were subject of a study ordered by The Ministry of Agriculture, last year, the results are published in this LUKE tutkimus report 12-2015

Menetelmäkuvaus

A. Mittari on Energy Return On Investment (EROI), jolla voidaan vertailla eri vaihtoehtojen energiatehokkuutta.

B. Suomen maatalous käsitellään suurena maatilana, ja holistinen peruslähestymistapa pyrkii ottamaan huomioon maatalouden ja maatilojen kokonaisuus.

C. Koska luotettavia epäsuoran fossiilisen energian kulutuslukuja on hyvin harvoin saatavissa, käytetään niiden arvioimiseen kahta menetelmää:

1. massaan ja muunnoskertoimiin perustuvia energiakulutuslukuja (LCA-lähestymistapa)
2. menoihin ja energiaintensiteettiin (kWh/€) perustuvia energiakulutuslukuja.

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My approach to discuss these questions may deviate from the mainstream approach because I focus rather on energy efficiency than on economic or environmental scales.

Yet I hope, that at the end of my presentation you accept that also the engineers point of view **can** explain, why all the excellent proposals to mitigate CO_2 emissions are difficult to realise because of one reason:

Polluting the environment is – for the time being – the cheaper alternative.

Within the 20 minutes I have, I will present only some highlights of my energy analysis to justify this statement.

The methodology bases on

A Calculation of energy return on investment

B Holistic farm model where the farm boundary = system boundary

C Fossil energy input calculation

A. Keskeinen mittari EROI (energy return on investment)

Sillä mitataan, paljonko energiaa tarvitaan "tuottamaan" energiaa:

EROI = (energy output) / (energy input)-1

Positiivinen EROI tarkoittaa energia-ylijäämää ja negatiivinen EROI energia-alijäämää. EROI=1 tarkoittaa, että nettoenergian tuotto on 100 %. Fossiilisen energian EROI on toistaiseksi suurempi kuin uusiutuvan energian EROI. IEA arvioi, että vuodesta 2020 lähtien hiili tulee olemaan tärkein maaöljyä korvaava energialähde. Se tarkoittaa, että fossiilisen energian EROI laskee vuoteen 2030 mennessä hyvin vähän.

Mitä suurempi uusiutuvan energian EROI on, sitä taloudellisempaa ja energiatehokkaampaa fossiilisen energian korvaus voisi olla. Eli kääntäen, mitä enemmän energiaa tarvitaan tuottamaan ja jakamaan energia kuluttajille, sitä vähemmän jää jäljellä muille kuin energiasektorille.

Esimerkki

Maatila kuluttaa 100 energiayksikköä fossiilista polttoainetta, jonka tuotannon EROI on 20. Siten fossiilisen energian kokonaiskulutus on 100+100/20=**105** fossiilista energiayksikköä. Mikäli maatila korvaa fossiilista polttoainetta uusiutuvalla polttoaineella, jonka tuotannon EROI on 2, uusiutuvan energian kokonaiskulutus on 100+100/2=**150** uusiutuvaa energiayksikköä. Mikäli energiapanos pysyy samana, olisi vain 70 (105=70+70/2) uusiutuvaa energiayksikköä käytettävissä.

Auto kuluttaa 100 yksikköä bensiiniä, jonka EROI on 4,25. Siten fossiilisen energian kulutus on 100+100/4,25=**124** fossiilista energiayksikköä. Mikäli bensiini korvataan sokeriruokoetanolilla, jonka EROI on 0,2, uusiutuvan energian kulutus on 100+100/0,2=**600** uusiutuvaa energiayksikköä. Mikäli tarvittava energiapanos pysyy samana, olisi vain 21 (124=(20,7+20,7/0,2) uusiutuvaa energiayksikköä käytettävissä.

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The energy return on investment (EROI) describes the ratio between energy output and input. An EROI > 0 means, that an energy production process delivers more energy than it consumes. The advantage of this measure is that energy input and output as well as resulting CO_2 emissions are comparable.

For example

A farm consumes 100 energy units of fossil fuels, exploited with an EROI of 20. Than the overall fossil energy consumption is **105** fossil energy units.

Given, the farm replaces the fossil fuel with renewable fuel, produced with an EROI of 2, the overall energy consumption of renewable energy is **150** renewable energy units.

In turn, if the energy input is limited to **105** energy units to maintain the same CO_2 emission level**,** than only **70** renewable energy units remain at the farms disposal.

Another example

A car consumes 100 gasoline units produced with an EROI of 4.25. Than the overall fossil energy consumption is **124** fossil energy units.

If we replace gasoline by ethanol produced from sugar cane with an EROI of 0.2 like we do in E95 gasoline, than the overall energy consumption of renewable energy is **600** renewable energy units.

If the energy input is limited to **124** to maintain the same CO_2 emission level**,** only **21** renewable energy units - that is 1/5th - remain at the car owners disposal.

USA:n talouteen simulaatio fossiilisen energian EROI muuttuessa

Valinnaisesti käytettävä toimeentulo laskee noin 50%:sta vuonna 2005 10%:iin vuonna 2050.

Oletus:
2007 EROI = 20:1
2030 EROI = 10:1
2050 EROI = 5:1

Output
BKT
Kulutus
Food
Valinnainen

Input
Energiahuolto
Energiahuollon panokset
Infrastruktuuri,kunnossapito
Investments
Valinnainen

Lähde: Hall, C., Powers, R., Schoenberg, W. 2008. Peak Oil, EROI, Investments and the Economy in an Uncertain Future. In: Pimentel, D. (ed.). Springer Netherlands. s 109-132.

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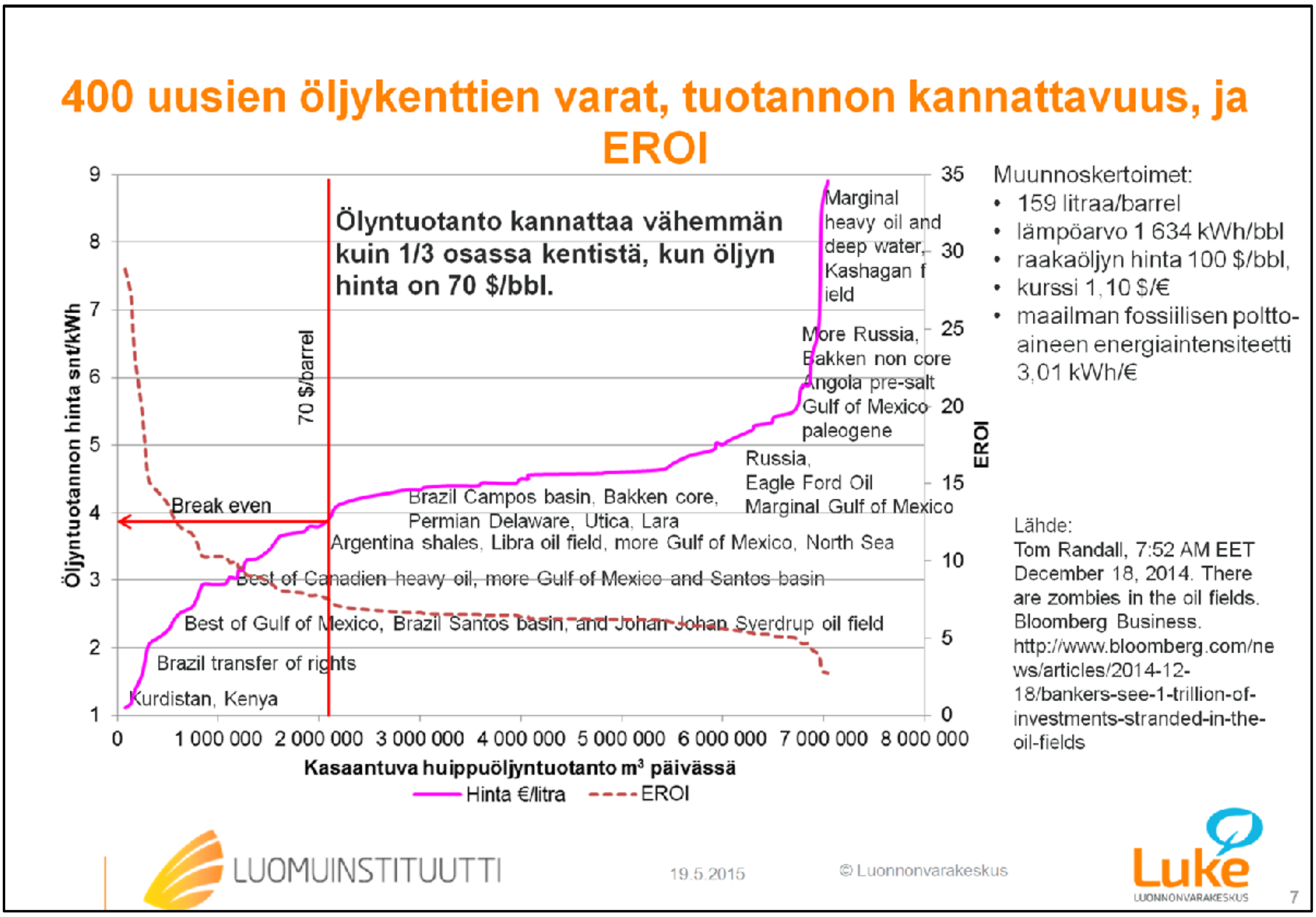
We can apply this example to the whole economy of a country or even the world. The example here shows the result of a model calculation for the US economy.

“The results suggest that discretionary income including both discretionary investments and discretionary consumption will move from the present 50 or so per cent in 2005 to about 10 per cent whenever - or if - the composite EROI of all of our fuels reaches about 5”, in other words, we will in future mainly work to produce energy.



The question now is: how does the EROI of fossil fuels develop in future?

To answer this question I cite a study from Goldman Sachs. After crude oil prices dropped 49 percent in six months, oil projects planned for 2015 are still standing upright, but with little hope of a productive future. These projects are in expensive arctic oil, deep water-drilling regions and tar sands from Canada to Venezuela.

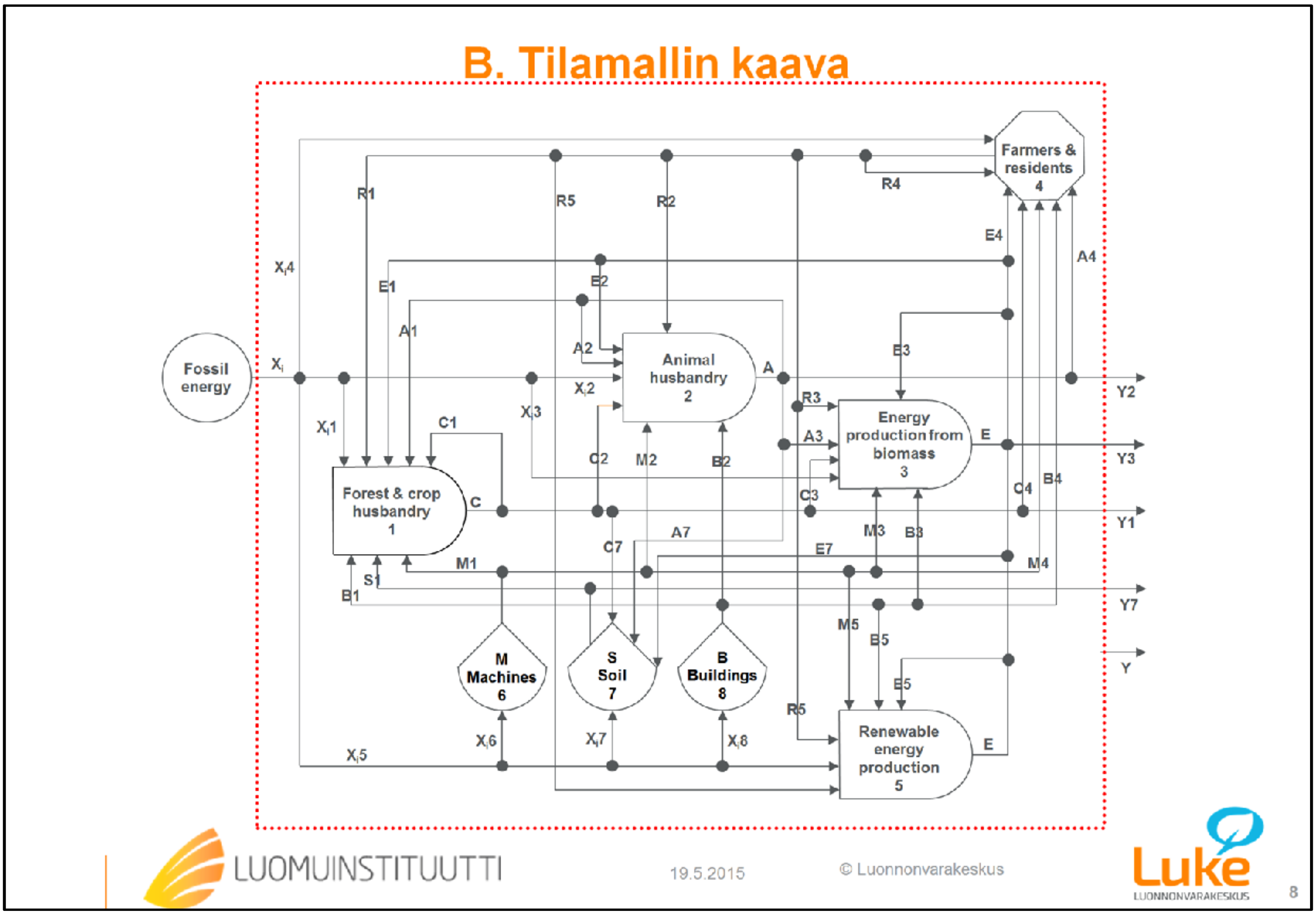
Goldman Sachs found almost 1 trillion $ in investments in future oil projects at risk. They looked at 400 of the world's largest new oil and gas fields -- excluding U.S. shale -- and found projects representing 930 billion $ of future investment that are no longer profitable with oil at 70 $.

The magenta line of the chart shows the break-even points for the top 400 new fields and how much future oil production they represent. Less than a third of projects are still profitable with oil at 70 $. If the unprofitable projects are closed, it would mean a loss of 7.5 million barrels per day of production in 2025, equivalent to 8 percent of current global demand.

If cheap oil continues, it could be a major setback for the U.S. shale oil boom. If the price of oil averages 70 $ in 2015, 150 billion $ will be pulled from oil and gas exploration around the world. An oil price of 65 $ dollars a barrel in 2015 would trigger the biggest drop in project finance in decades.

A pause in exploration and development may sound like good news for investors concerned about climate change. However these prices can't stay low forever. Oil production hasn't slowed yet, but as zombie projects go unfunded, it will. This is how the boom-bust-boom of the oil market goes: prices fall, then production follows, pushing prices higher again".

However, please note, the EROI (red dotted line added by me) of present oil and gas fields will never change.



Now let us apply the EROI as a measure in the farm energy analysis

We may consider Finnish agriculture as a big farm embracing several production processes, storages and consumers.

Than we analyse the impact of fossil fuel input reduction on the different processes and on the farm output like food, feed, fibre, and fuel as well as losses and emissions.

While the energy of fossil fuel is easy to quantify via the heat value, the energy content embodied in goods and services is not easy to determine.

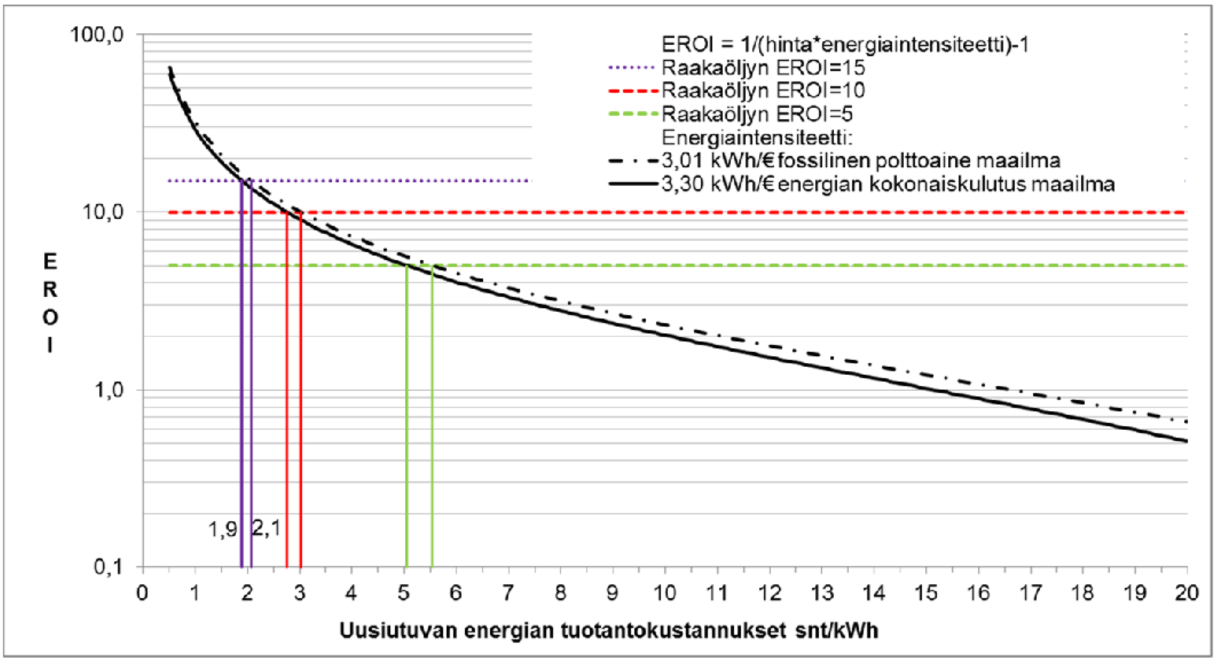
Thus I used two methods to calculate energy input and output:

1) mass and mass to energy conversion factors (common in LCA)
2) expenditures and energy intensity (kWh/€).

The energy intensity is the gross domestic product divided by the consumed energy.

Presently the energy intensity of the world economy is about 3 kWh fossil energy per €.

EROI:n vaikutus uusiutuvan energian kilpailukykyyn



Uusiutuvan energian EROI tuotantokustannuksista ja energiaintensiteetistä riippuen. Mikäli raakaöljyn oletettu EROI on 15, vastaava tuotantohinta on noin 1,9 – 2,1 sentti/kWh maailman energiaintensiteetin 3 – 3,3 kWh/€ perusteella. Raakaöljyn maailman markkinahinta on noin 4,5 sentti/kWh. Ero edistää maailmantalouden varakkuutta. 158,99 litraa/barrel (bbl), lämpöarvo 1 634,38 kWh/bbl, raakaöljyn hinta 100 $/bbl, kurssi 1,35 $/€

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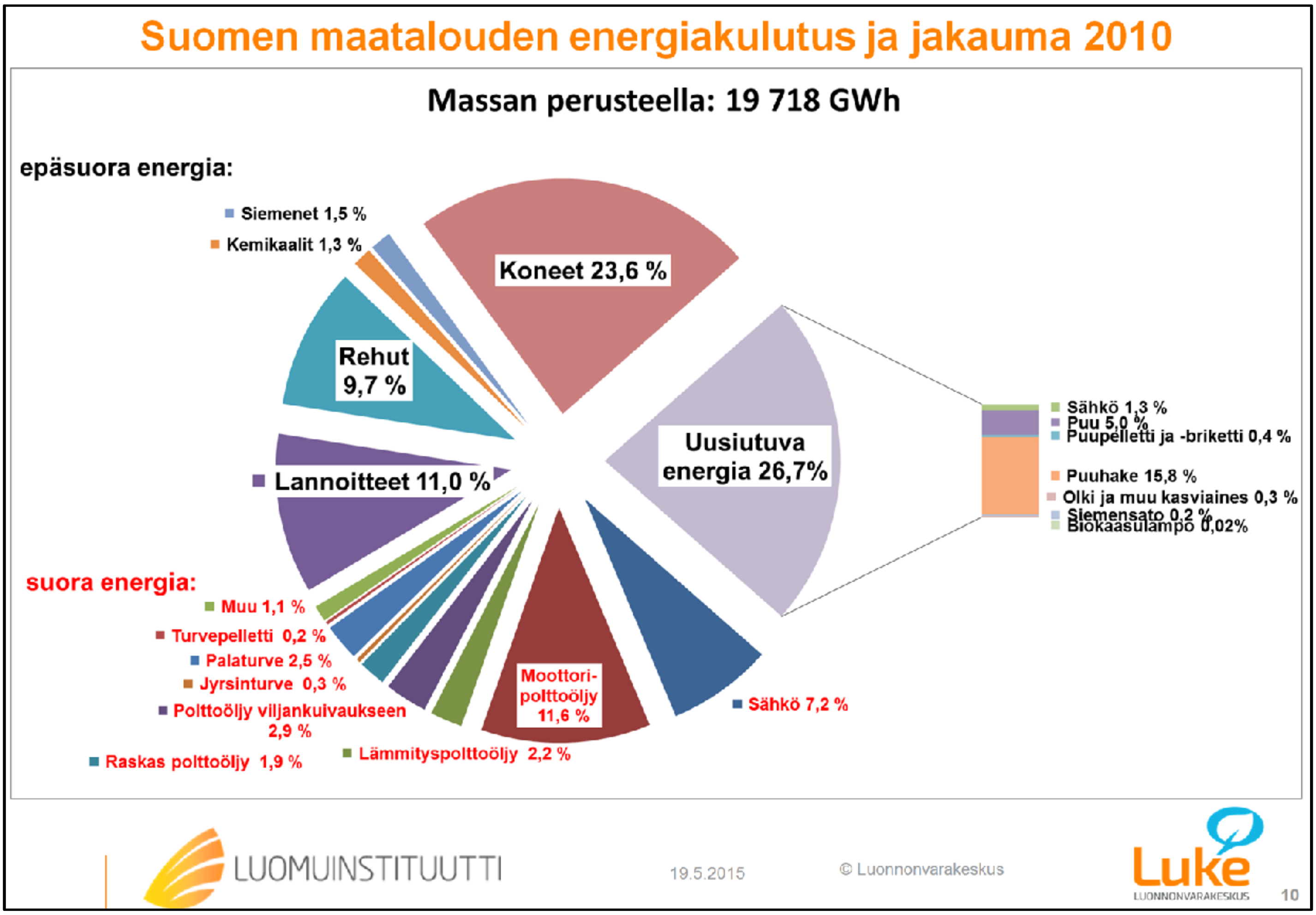
This graph allows us to compare different scenarios:

Presently the average EROI of oil is estimated to 15 (violet lines) resulting in a production price of 1.9 to 2.1 c/kWh.

In future exploitation of oil may become more difficult, requiring a higher energy input resulting in a lower EROI of 10 or even 5, which in turn rises the production price to between about 3 c/kWh (red line) and about 5 c/kWh (green line) respectively.

If we know the production cost of 1 kWh renewable energy, we can compare, whether the renewable fuel is competitive.

The price for wood chips for example is 2 c/kWh and therefore very competitive with oil for heating purposes, the price for biogas based on heat value without storage and distribution grid is about 4 to 8 c/kWh .



Here we see the energy input of Finnish agriculture calculated on mass basis.

The red labels mark the direct energy input, the black ones embodied energy input.

Most important direct energy inputs are engine fuel, electricity, and heating oil for drying.

Fuel oil input makes only 19% of the total energy input.

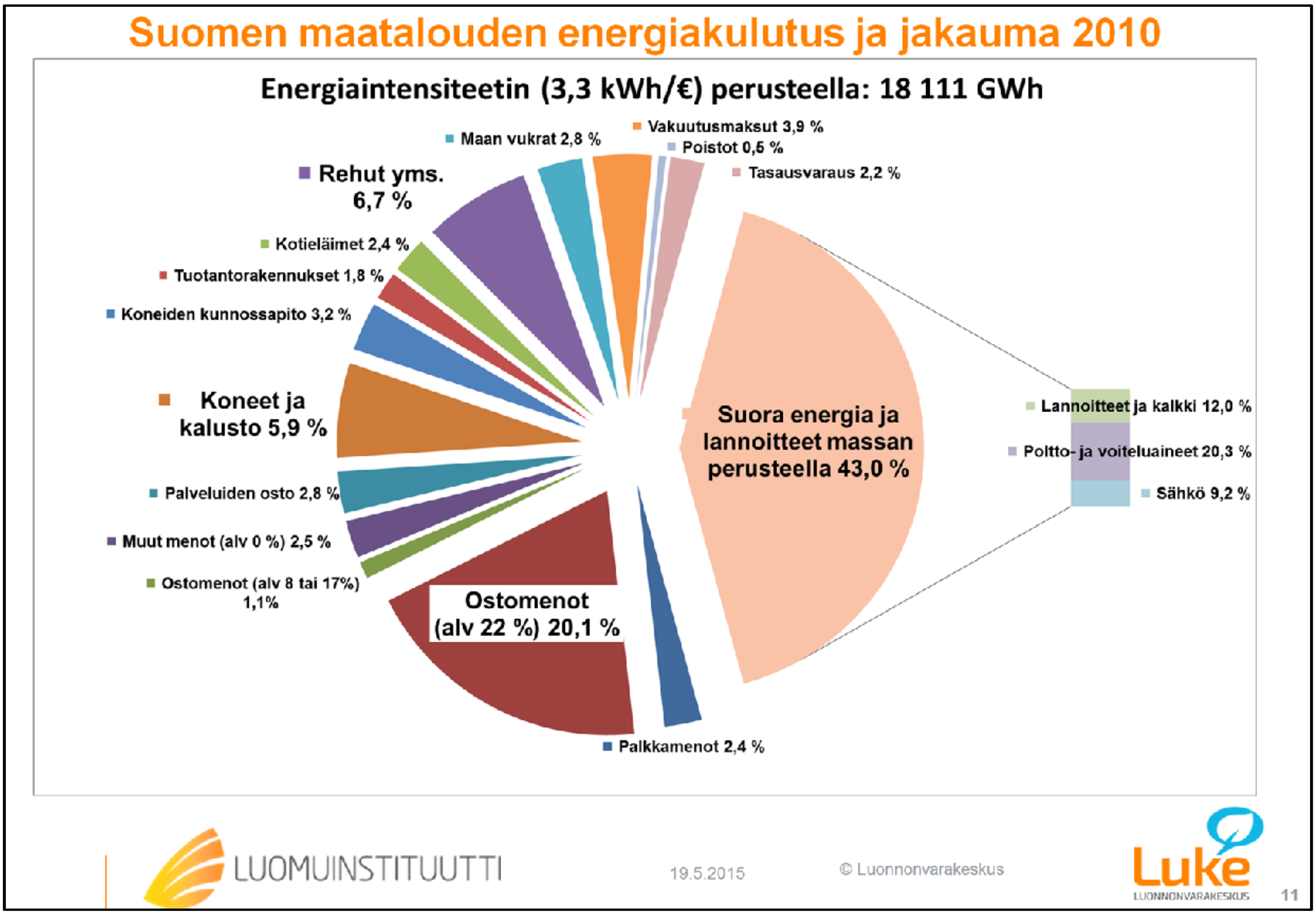
The embodied fossil energy input of agriculture is about 47% and exceeds the direct fossil energy input which amounts to about 26% of the total energy input.

Most important indirect energy inputs are machinery, fertilisers, and feed.

The right block shows different types of renewable energy input which covers already now more than a quarter of the total energy input.

Direct and embodied fossil energy sum up to about 14.4 TWh that is about 6250 kWh/ha corresponding 625 litre oil

Thus we can conclude that replacing fossil fuels by renewable ones has a very little impact on CO_2 mitigation.



Similar results we receive applying the energy intensity methodology.

Here we see the results based on the expenditures of Finnish agriculture after Statistics Finland.

The calculation on basis of energy intensity leads to similar results as the calculation on mass basis in terms of overall energy input.

However the embodied energy of machinery is one magnitude greater than on mass basis. There may be two reasons:

First, the machinery figures calculated on mass basis are 10 years old and concern the manufacture of machinery in Finland not the machinery on farm.

Second the mass to energy conversion factor is too high and the energy intensity for production of machinery is too low.

Direct energy input and fertiliser input were calculated on mass basis, because the energy intensity underestimates the heating value of fuels and the high fossil fuel input to produce fertilisers.

Here, the direct energy input figure does not distinguish between renewable and fossil energy input.

Yet the total energy input calculation of both methods shows similar results (19% fossil+26% renewable= 45% on mass basis, 43% on energy intensity basis)

Menetelmäkuvauksen keskeiset tulokset

- Fossiilisten polttoöljyjen korvaaminen uusiutuvilla polttoaineilla lisää energian kulutusta ja maataloustuotannon tuotantokustannuksia
- Huomattavasti tehokkaampi hiilidioksidipäästöjen vähentämiskeino on epäsuoran fossiilisen energian vähentäminen. Suurin potentiaali lienee maatilojen tuotannon monipuolisuuden edistämisessä. Luonnonmukainen tuotanto sekä monitoiminnalliset maatilat toteuttavat näitä jo. Ulkomaisten tutkimustulosten mukaan vähentämispotentiaali on jopa 50 % (FAO 2003, Mäder et al. 2002, Gattinger et al. 2012, Skinner et al. 2014.)
- Maatilalla ja/tai maaseudulla tuotettu uusiutuva **moottoripolttoaine** ei ole toistaiseksi kilpailukykyinen fossiilisten moottoripolttoaineiden kanssa EROI:lla mitattuna.
- Maataloudessa tehokkain tapa vähentää Suomen CO_2 päästöjä olisi käyttää hyväksi maataloustuotteiden entropiaa. Niin säästetään fossiilisen energian kulutusta maatilan ulkopuolella (esim. kuitukasvista tuotetut eristeet tai raaka-aineet, jotka korvaavat fossiilisella energialla tuotettuja tuotteita).

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Lessons learned from these facts:

Substitution of fossil fuels by renewable ones increases energy consumption and production costs.

More important is the mitigation potential of embodied energy in goods and services.

Renewable engine fuel, produced from biomass, is not competitive with fossil fuels in terms of EROI.

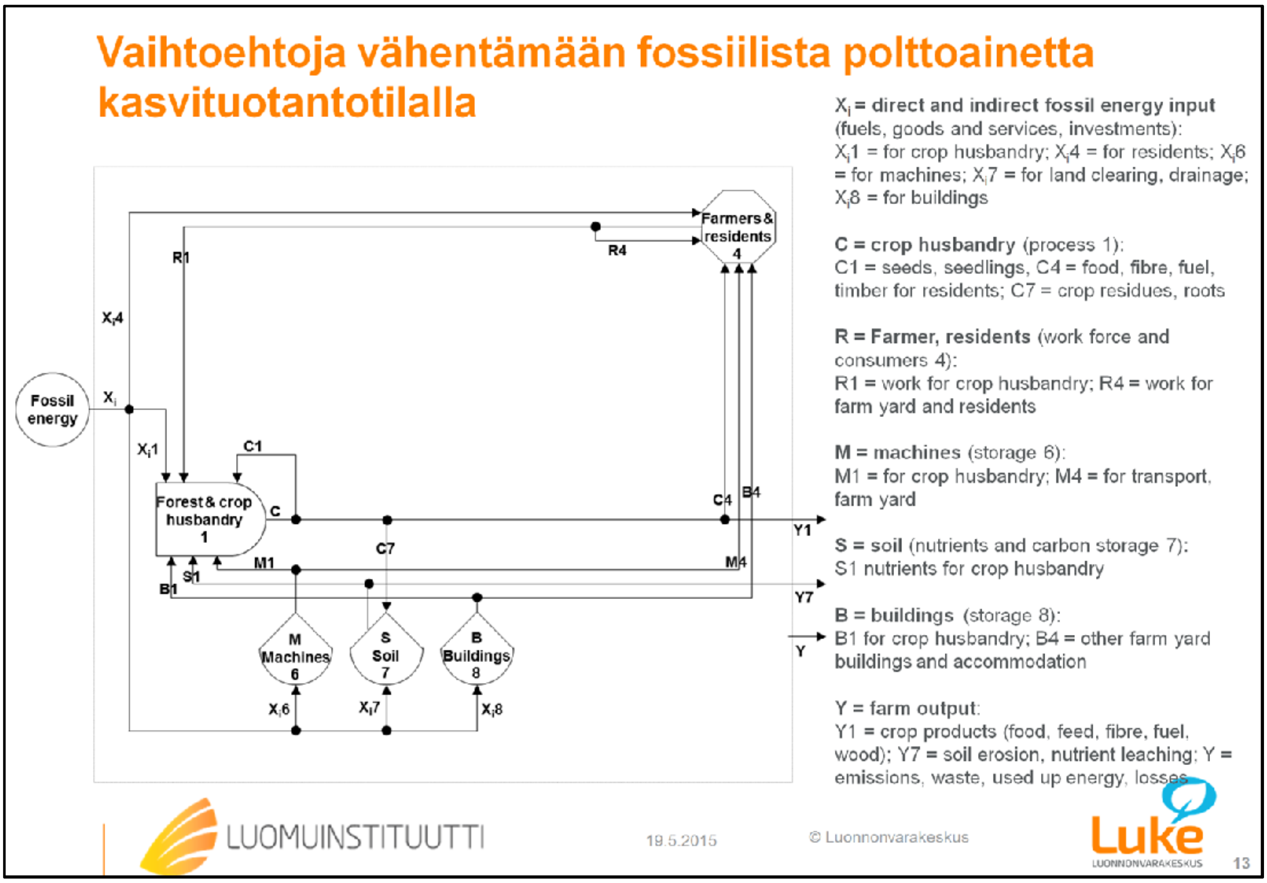
The same is valid for renewable energy techniques. E.g. Kalmari claims, that the energy of one ha biomass replaces gasoline to drive a car 40 000 km with biogas. If we apply the same calculation method on solar technique, than the energy converted from one ha solar panels would be enough for 5 000 000 km of a electricity powered car.

In agriculture the most efficient way to mitigate CO_2 emissions is, to include the entropy of agricultural products in energy policy decision making.

E.g.: Even though energy from wood may have a high EROI, processing fuels from wood of low entropy makes no sense: Producing a table from a tree and burning the residues and the table at the end of its lifetime renders the same energy gain as using the tree for firewood only.

Organic crop production saves the embodied energy of nitrogen fertilisers and the improved soil fertility may absorb up to 50 % of the CO_2 emissions of agriculture.

Now we look at the impact of replacing fossil fuels by renewable ones on farm level



The most effective and simple way to reduce CO_2 emissions on farm level is outsourcing fossil fuel consuming work. E.g., the farmer may reduce CO_2 emissions buying electric power produced from renewable resources, giving all fieldwork to a contractor obligated to use biodiesel, and using wood chips for heating the buildings.

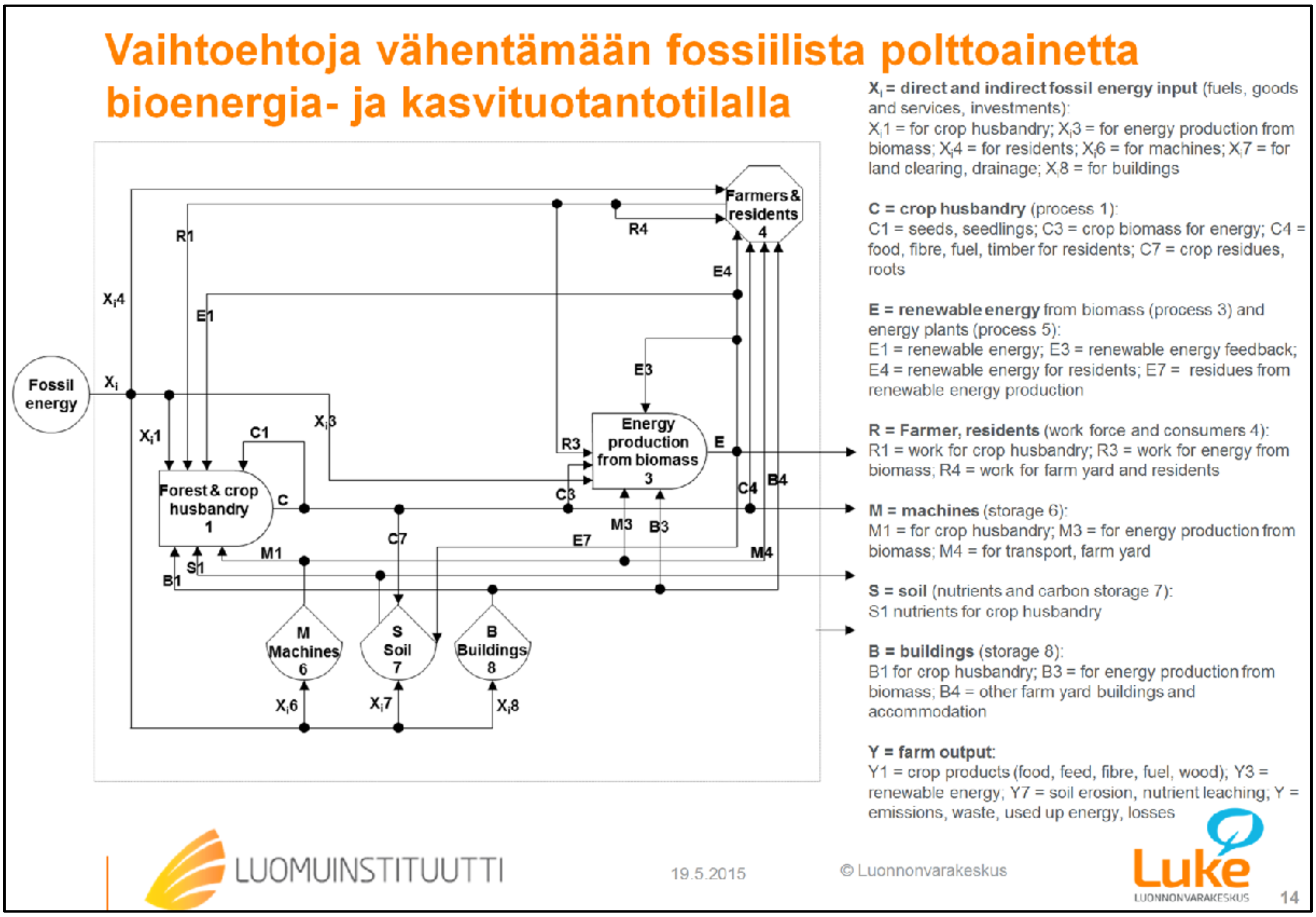
Than the CO_2 mitigation of the farm is nearly 100% in respect of direct fossil fuels. It is obvious that these actions will not reduce the Finnish CO_2 balance. However, the same questionable practice is officially accepted on national level: To improve the Finnish CO_2 balance, Neste imports valuable energy rich food of low entropy like palm oil to substitute import of fossil fuels.

Green manure crops may replace fertilisers, use of on farm produced seeds and seedlings (C1), and/or recycling organic residues (C1, C4) lowers indirect fossil energy input. As a following both Y1 (yield of food, feed, fibre, and wood) and Y7 (emission of CO_2 and leakage of nutrients) may decrease. Recycling organic matter improves soil fertility and may absorb up to 50 % of the CO_2 emissions of agriculture. However, production cost will rise.

If we replace tractors by animal draught, Xi1 and Xi6 will decrease on cost of Y1. R1 will considerably increase. Fertilisers may partly be replaced by compost from organic residues. CO_2 balance will improve sustainably. The proposal is not suitable for big farms, but creates synergies for multifunctional farms and green care farms.

Replace tractors by solar powered gantry technology combined with precision farming techniques. This technique may also be combined with animal draught. Although the technical components for this technique are available, the concept is not realised yet and should become subject of research. The CO_2 balance will improve only, if the EROI of this technique is greater than that of fossil fuels.

Increased handwork (R1) e.g. to substitute embodied energy of agrochemicals makes no sense as long as human work (60-300 W) is extremely expensive (>10€/h) resulting in an energy price of (33 to 167 €/kWh).



If the crop production farm additionally supplies energy, the model may look like this:

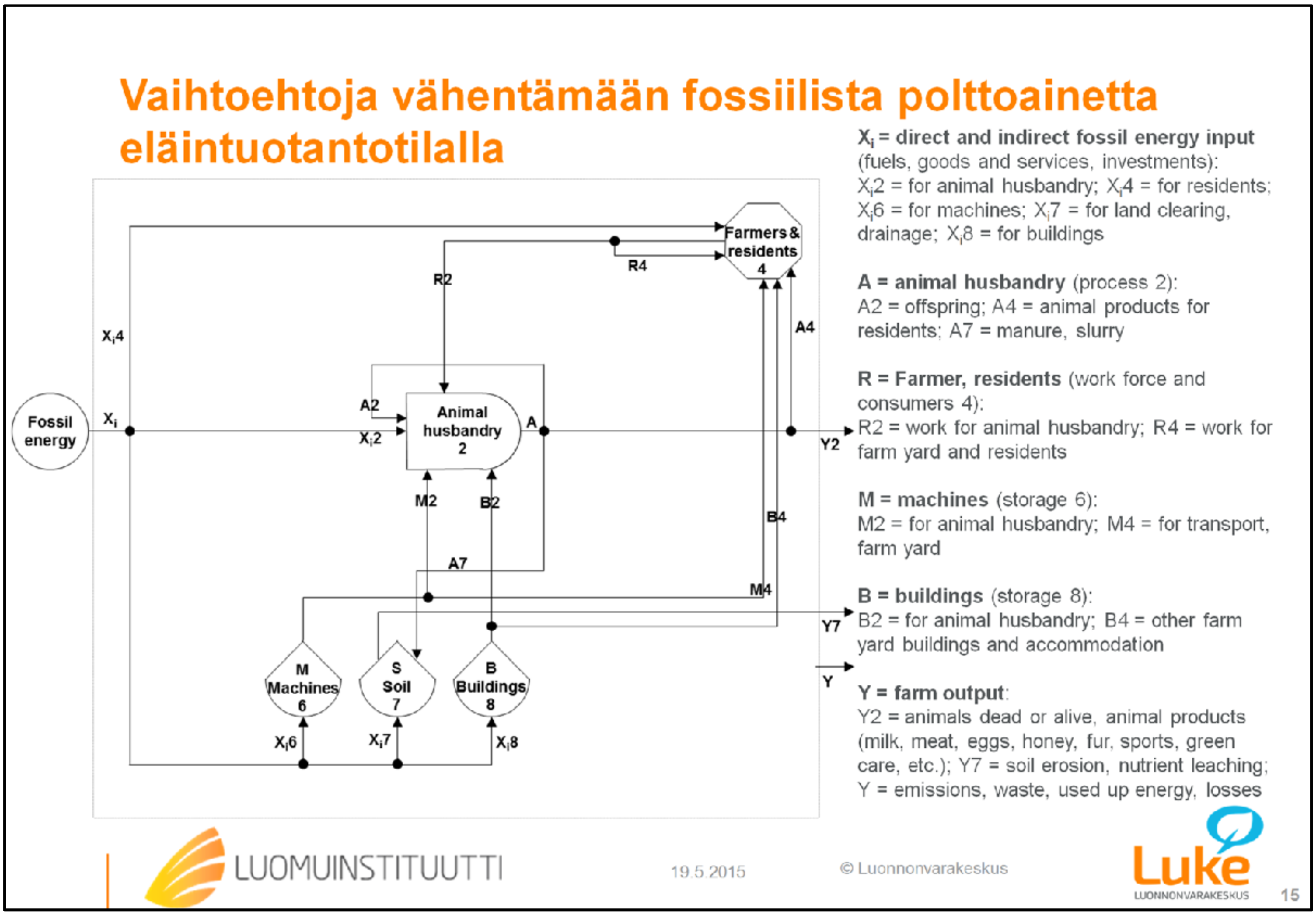
Straw is often considered as renewable energy source of crop production farms. However, any crop residue withdrawn from soil (C7) affects the soil fertility and thus the CO_2 storage ability of soils. The EROI of straw in district heating plants is 8 only.

Typical energy crops are Salix and in Finland RCG. The EROI in terms of heating values is quit high and ranges from about 7 (Miscanthus), 25 to 40 (Salix) up to 50 (Pine) if Xi1 is considered as the only input. However, the EROI of solid biofuels decreases rapidly if biomass is converted into liquid fuels or electricity. The EROI of rape is hardly competitive with fossil fuels.

Production of fibre crops like RCG as fuel (C3) is not competitive with wood but fibre crops may be used in bio-economy as raw material for insulation. Insulation fibre of one ha RCG may save 19 to 69 times more CO_2 eq emissions than burning the fibre if we may save the equivalent energy quantity of heating oil.

Production of biogas from crop residues makes no sense because heat and power from biogas plant are generated continuously, but consumption on this farm type is depending on season and daytime. To power farm machinery or cars with biogas, storage and compression facilities would be necessary. This worsens the low competitiveness of biogas production.

Use of wood gas to power machinery. This alternative is covered by recycling organic residues (C1 replaces Xi1 in terms of diesel). Wood gas generation was applied for farm machinery during world war two but requires considerable modifications on existing machinery and is presently not realistic on farm level although it may improve the CO_2 balance.



Animal husbandry farm

Animal husbandry farms like fur, pork, and poultry production and horse farms without crop production are the worst nutrient (Y7) and CO_2 (Y) polluters of all farm types. Like in industrial factories, the only possibility to reduce CO_2 emissions of fossil fuels is to save energy that is to reduce Xi. Biogas from manure only is not competitive at all but may mitigate nutrient losses.

Strategies to reduce fossil fuel consumption of the animal production farm are:

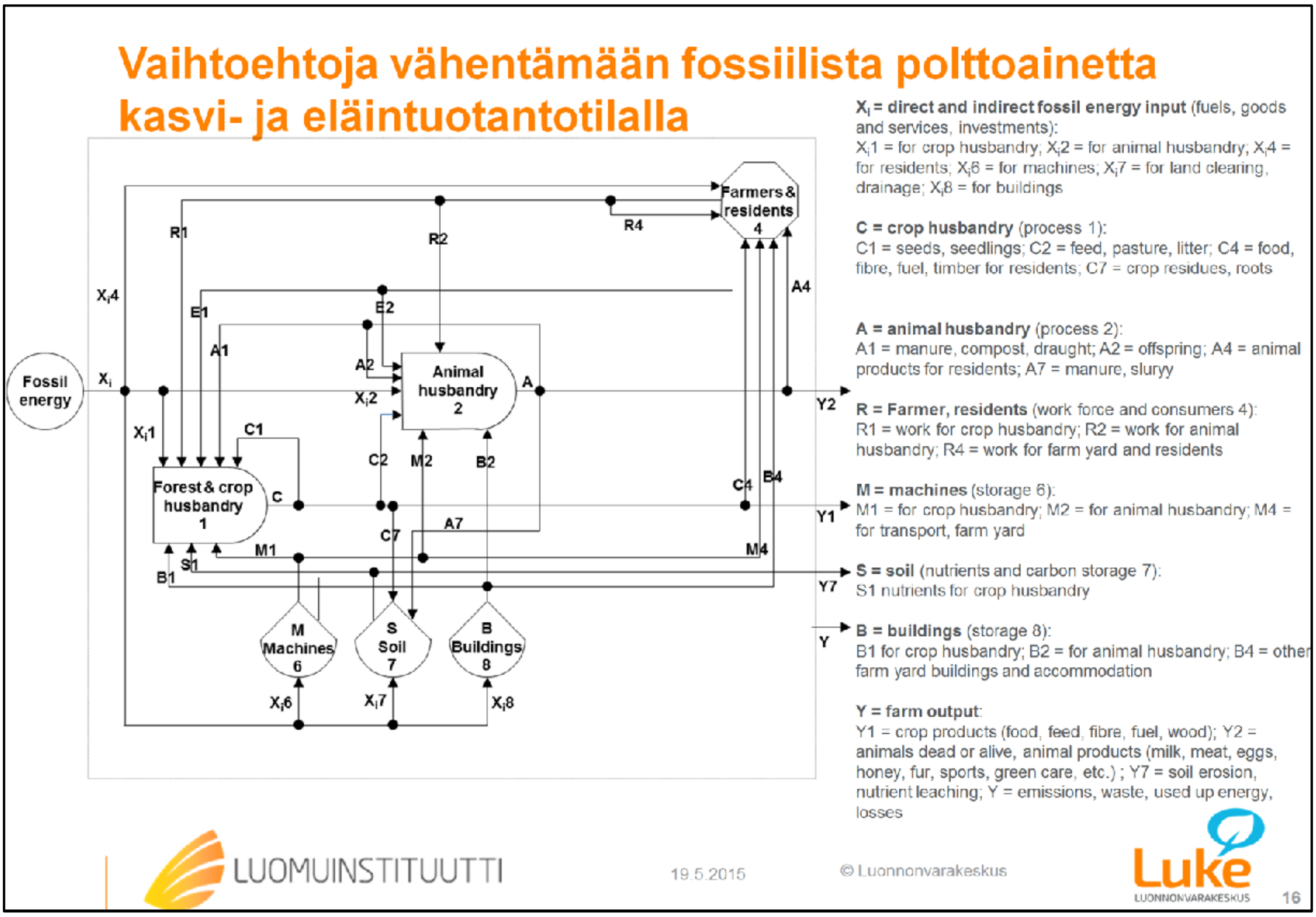
Insulation of buildings

Installation of electric power saving equipment (lightening, conveying, air conditioning)

Installation of heat pumps to recover heat from air condition and cooling facilities

Earth heat pump, air-air heat pump, air-water heat pump for heating buildings

However, all these measures increase production cost and require an greater energy input as long fossil fuels render a higher EROI.



The mixed farm has the greatest potential for CO_2 mitigation because it offers a great extent of self-sufficiency. Especially organic mixed farms save about 50% of fossil energy. The natural and - in respect of energy efficiency - most efficient mixed farm produces according to its natural resources: energy from animal draught, forest, wind, and waterfalls, food, feed, and fibre from the available arable land, milk and meat from the available pasture land, poultry from waste cereals on pork from organic waste. Manure and crop residues not usable for fodder are composted and thus the nutrient cycle is nearly closed.

Following actions may reduce fossil energy consumption:

- Plan crop rotation and number of animals to reach self-sufficiency of feed and nutrients
- Produce own animal offspring and own seed (A2, C1)
- Recycle nutrients by composting organic materials not suitable for feed (C7, and A7)
- Consume and process farm products as much as possible on farm (C4, B4)
- Compensate higher production cost by multifunctional agriculture (Community Supported Agriculture, green care farming, eco-villages and so on)

Green care farms emerging throughout Europe transfer "multifunctionality" into practice. They are usually organic mixed farms and meet the demand of policy makers to create jobs in rural areas offering social services.

However, the present agricultural policy considers this farm type as old fashioned and unable to meet the economy of scales. Although there are some farms in Finland managed according to this principle, there is very view scientific research results available indicating that this farm type is most efficient in terms of fossil energy use and nutrient recycling. First attempts to do such research were made within the European BERAS-projects.

Johtopäätökset

- Fossiilisen energian EROI pysyy luultavasti seuraavat 50 – 100 vuotta korkealla tasolla. Maaöljy ja maakaasu korvataan hiilellä, Suomessa myös ydinvoimalla, turpeella ja puulla.
- Fossiilisen moottoripolttoaineen korvaaminen uusiutuvalla polttoaineella aiheuttaa aina lisäkustannuksia, koska kaikki nyt tiedossa olevat uusiutuvan energian tuotantotekniikat kuluttavat enemmän energiaa kuin fossiilisten polttoaineiden huolto. Toisin sanoen: Ympäristön saastuttaminen käyttämällä fossiilista moottoripolttoainetta on – toistaiseksi – Suomen maatilojen kilpailukykyisin vaihtoehto.

ESIMERKKI

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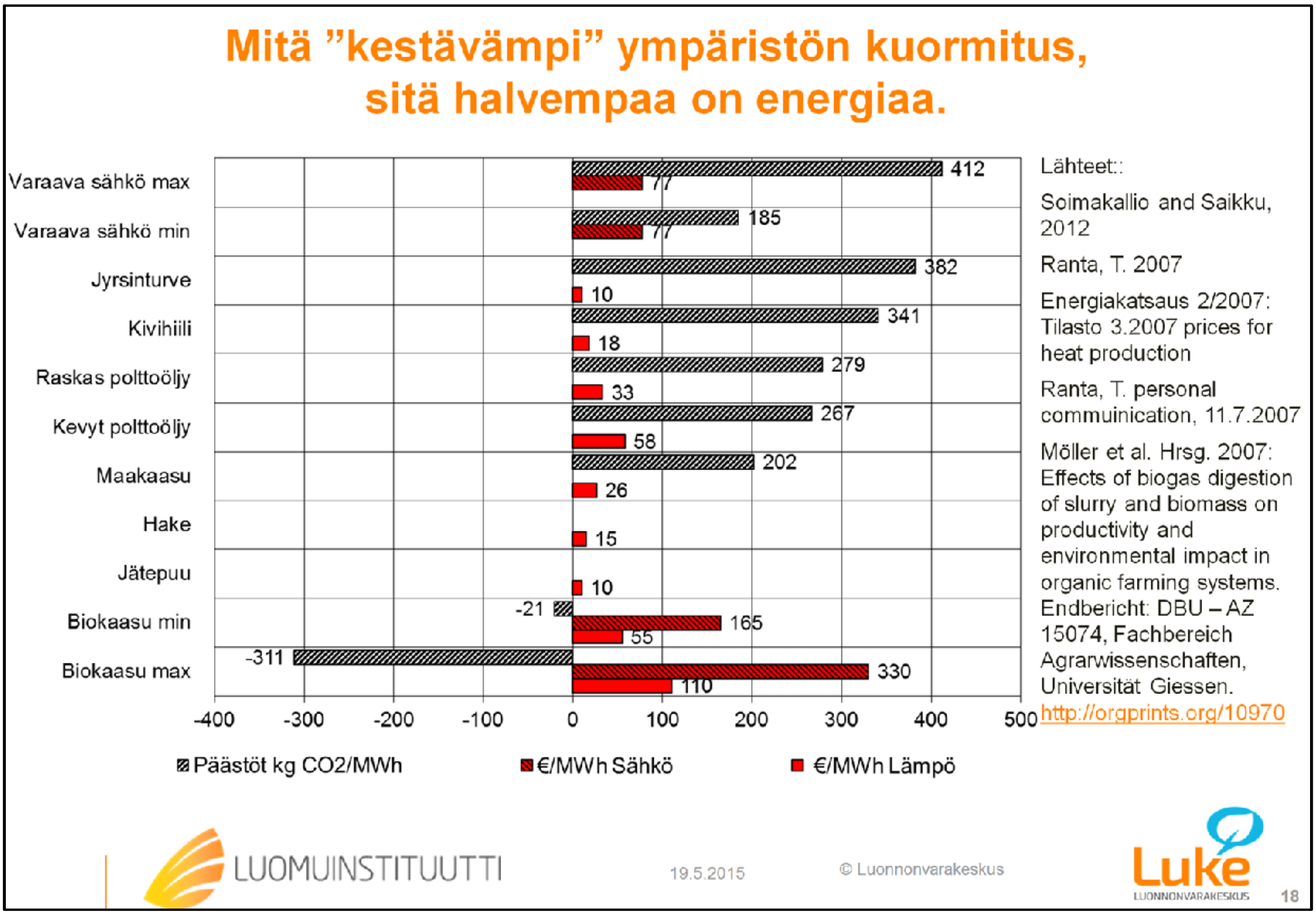
Conclusions:

The EROI of fossil fuels remains probably on high level during the next 50 to 100 years. Oil an gas will be replaced by coal, in Finland also by nuclear power, peat and wood.

Substitution of fossil fuels by renewable ones causes always additional costs, because all known techniques to provide renewable energy need more energy than fossil fuel exploitation. In other words: Polluting the environment is - for the time being – the most competitive alternative for Finnish farms.

EXAMPLE



Polluting the environment using fossil fuels is - for the time being - the most competitive alternative

Johtopäätökset

- Vaikka biomassa on enemmän uusiutuvaa kuin fossiilista polttoainetta, sen EROI on fossiilista polttoainetta pienempi ja korvaaminen ei vähennä CO_2 päästöjä.
- Maailman lämpötilan nousu pakottaa ihmiskunnan korvamaan fossiilista polttoainetta uusiutuvilla. Ainoa kestävä vaihtoehto saavuttaa tämä tavoite on vähentää fossiilisten polttoaineiden louhintaa. Siihen ei ole olemassa keinoja kansallisella tasolla.

Although biomass is more renewable than fossil fuels, its EROI is lower and substitution will not reduce CO_2 emissions

Climate change may force humankind to reduce fossil fuel consumption. The only sustainable way to achieve this is reduction of fossil fuel exploitation. However this is not possible on national level.

Suositukset

- Kehittyneiden maiden maatalouden EROI on negatiivinen. Siksi maatilojen on ensiksi korvattava itse kuluttamansa fossiilinen energia uusiutuvalla energialla.
- **Luomuviljelyn laajentamisella** voidaan tappaa kolme kärpästä (= kolme skenariota) yhdellä iskulla: 1) maatalouskemikaalien (tyyppilannoituksen) fossiilisen energian tarve laskee, 2) eläinperäinen ruokavalikoima laskee ja kasviperäinen ruokavalikoima nousee (oman rehun tuotanto ja viljelykierto), 3) mikäli elintarvikkeiden tuontia on pakko nostaa laskevan omavaraisuuden vuoksi (esim. pienempi sato), CO_2 -päästöt siirretään ulkomaille.
- **Kestävä poliittinen keino vähentää CO_2 -päästöjä, fossiilisten polttoaineiden ja luonnon resurssien kulutusta olisi verottaa niiden kulutusta työn verotuksen sijaan.** Toteuttaminen on epärealistista niin kauan, kuin talouskasvun paradigmasta ei luovuta. Lisäksi toimenpide edellyttäisi, että sitä sovelletaan koko maailmassa takamaan kansantaloudellinen kilpailukyky.
- Toinen keino on ”polluter pays” -menetelmän soveltaminen (esim. CO_2 sertifikaatit, typpilannoitteiden verotus askelittain niin korkeaksi, että orgaaninen lannoitus tulee kilpailukykyisemmäksi).

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Recommendations:

Finnish agriculture consumes more energy than it produces. Therefore substitution of fossil fuel has to start on farm level.

Promoting organic production may kill three birds with one stone:

1) Fossil energy embodied in agrochemicals is excluded and CO_2 sequestration of the topsoil may be enhanced.
2) Food from animal production will decrease and food from crop production may increase because of increased biodiversity based on fodder production and crop rotation.
3) In case that lower crop yields cause increased import of food to maintain the level of self-sufficiency, CO_2 –emissions are outsourced.

A sustainable way to mitigate CO_2 emissions is, to tax consumption of fossil fuels and natural resources instead of human work. Realisation may be impossible as long as the paradigm of economic growth has the first priority. Further the proposal requires that it is applied all over the world to ensure competitiveness.

Another mean is to introduce the ”polluter pays” principle. This may include labelling conventional produced food like “produced using artificial fertilisers and pesticides in compliance with EU-legislation”, CO_2 certificates, or stepwise taxing agrochemicals on such a level, that organic fertilisers and pest control become more competitive.

Ulospääsy

- Jatketaanko siirrtää CO_2 -päästöt ulkomaille kaunistamalla kansallista CO_2 -tilastoa (palmuöljyn, rehujen, elintarvikkeiden, aurinkopaneelien tuonti)**?????**
- Fossiilista energiaa käytetään hyväksi kehittämään tekniikoita, jotka tallentavat aurinkoenergiaa hiilivety-yhdisteisiin (nesteet ja kaasut). Aurinkoenergian muunnostehokkuus biomassaksi (fotosynteesi) on Suomessa promillen suuruusluokkaa, teknologiset muunnostehokkuudet ovat prosenttisuurusluokassa.
- Hyväksytään, että maa- ja metsätalous on ainoa talous, joka voi vähentää entropiaa, eli maatila ei ole teollinen tuotantoyksikkö. Tai onko muita syitä, että tarvitaan maa- ja metsätalousministeriö? Korvataan tuotantoketjuajattelu systeemiajattelulla, eli

”Moving from Egosystem to Ecosystem Awareness“

Siirtyminen minä-keskeisestä järjestelmästä tietoisuuteen elollisen luonnon muodostamasta kokonaisuudesta, Otto Scharmer, Massachusetts Institute of Technology (MIT), Presencing Institute, www.presencing.com.

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Ways out

Fossil fuel may be increasingly used to develop techniques for the synthesis of carbon hydrates from CO_2 because the conversion efficiency of sun energy into electricity and heat is up to 100 times more efficient than photosynthesis.

In the light of these techniques and their high efficiencies, energy crops for fuel technologies have no future.

Outsourcing of CO_2 emissions to improve the national CO_2 balance: for example import of palm oil, ethanol, feed, food, solar panels.

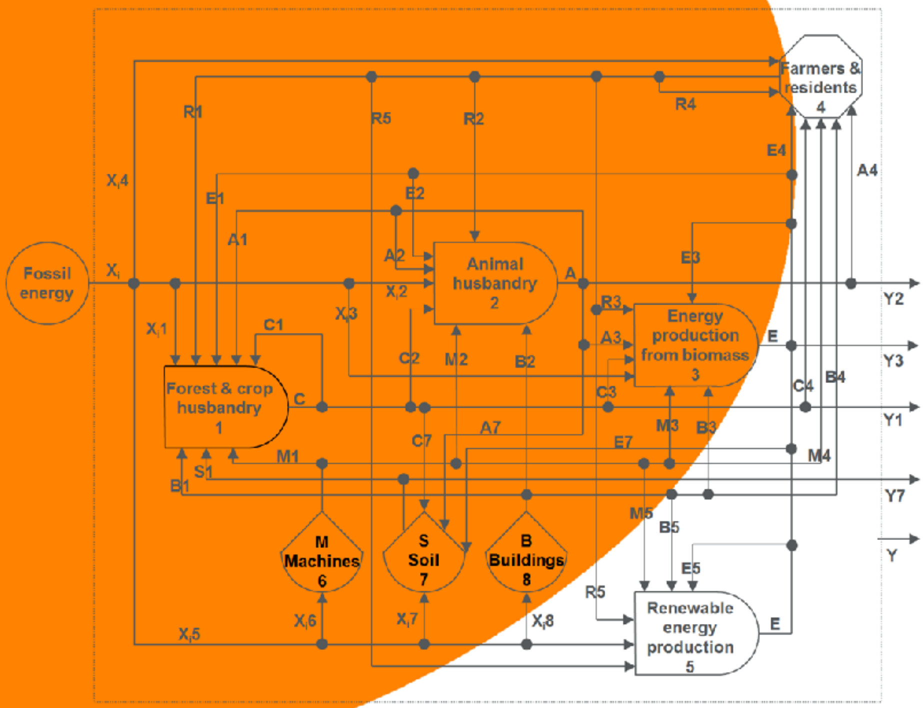
Recognising the fact that only agricultural production - and I stress here the word culture – decreases entropy.

This is the strongest argument to justify the existence of an agricultural ministry although the economic impact of agriculture upon the gross domestic product is quite small:.

Thinking in systems instead of chains requires also a paradigm change as the future researcher at MIT Otto Scharmer states:

”Moving from Egosystem to Ecosystem Awareness“

Kiitos!



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