

Bioenergy markets and policies, 2018



Learning portfolio

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Basic concepts in Bioenergy

In general, bioenergy is understood as the production of energy through biological sources such as food, forests or other biomass sources. It is also known as a renewable source of energy and is considered as an environmentally friendly. The leading countries for bioenergy business are mainly Finland and Sweden and their major feedstock sources are forest-based sources due to high availability. Bioenergy can be produced either by solid biomass or from liquid sources. The most common sources of biomass production can be divided into solid, wet (liquid), starch plant and oil crops. They all have different conversion technologies in bioenergy production such as making of chemicals, ethanol and fuels. There are also varieties of methods depending upon the need, combustion methods produce the heat energy while extraction is used for biodiesel production. Some conversion techniques are listed below:

- Solid biomass (e.g. wood) → combustion, gasification, pyrolysis → Heat, biogas, fuel.
- Wet biomass (e.g. organic waste) → digestion → Biogas, used as fuel.
- Oil crops and starch plants → fermentation/extraction → Biodiesel/bioethanol etc.

When we talk about bioenergy, forest-based products play an important role in fulfilling the feedstock value due to the fact that almost every single part of a tree can be utilized in producing energy. However, more agro based resources are used to produce bioenergy outside the EU-nations such as agricultural residues. The situation of EU countries during 2000^s period was mainly dependent on the fossil fuel-based sources imported from third countries as their energy sources such as natural gas, coal and oil. However, due to the vulnerability and to maintain the energy security, utilization of forest-based sources has significantly increased in last 50 years. The usage of municipal waste into energy production is also a common way of producing energy in many countries. In Sweden, municipal wastes are used in fast growing plantation willow. However, special precaution needs to be done because of the possibility of toxic chemicals involvement. The common fast-growing plantations/ short rotation trees are for instance willow, eucalyptus, poplar etc. and they are fulfilling the energy demand in many countries due to their fast-growing nature. Moreover, they can also work as a feedstock source for combustion in district heating power plants in countries like Finland.

However, due to the hygroscopic nature of wood, supply chain has to be effective in order to eliminate the moisture in feedstock. The major concern with wood handling is to avoid moisture absorption which can be done by many techniques such as wrapping of wood properly, by using advance harvesting technologies as well as better logistics [1] [2].

The role of policy on bioenergy markets

Policy is something that guides either government or an organization with its principles. The increasing demand of bioenergy market has created extra attention to the policy makers from local, national or even to the EU level. This is because of degrading global environmental concern and is believed that approaches in bioenergy sector can help the matter with its sustainability and renewability nature. However, bioenergy market in global scale have not gone yet more than 10 % but it is considered to have a huge potential in energy sector. There are third parties who using an economic tool 'externality', are linking economics and an environment. Externality factor has also importance in forestry in many aspects for instance of soil and water conservation, biodiversity, landscape, carbon market etc.

The policy regarding bioenergy is one of the renewability energy concept and EU has set the policy mainly in three parts which are listed below:

I. Energy policy

Policy was set to secure the energy supply. EU has also implemented energy policy in many different stages in 1997, 2001, 2003, 2006, 2007, 2008 etc. Taxes subsidies etc. are implemented to meet the objectives. The latest 2009 EU directives has ambitious plans to have at least 20% of total energy should be generated from renewable sources by 2020.

II. Agricultural policy

EU has implemented this policy to increase productivity and to secure the food supply. Further, to maintain the fair standard of living for agricultural population which can be done by securing reasonable retail price for customers. CAP (common agricultural policy) is one of the very important policy in EU and most of the EUs budget applies in this area. This policy is one of the reason why countries like Norway and Iceland are not in EU even though they are in Schengen.

III. Environmental policy

This policy is adopted to prevent the climate change condition by encouraging investors in green technologies and practices which can reduce the carbon emission and at the same time create employment opportunities. Kyoto protocol, European union emission trading scheme (EU ETS) are some of the organizations working in climate or environmental sector.

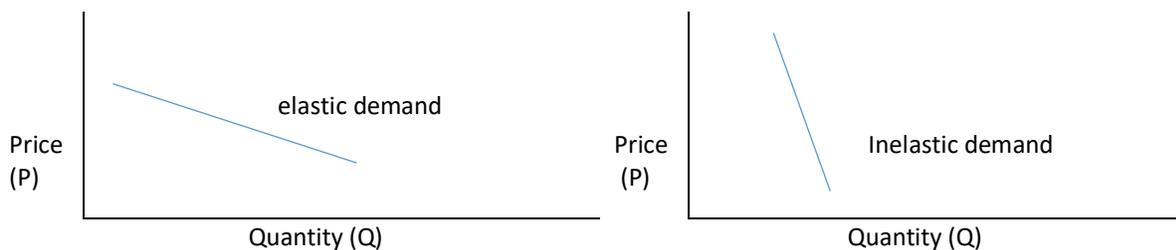
Besides above-mentioned policies, each country have their own national bioenergy policies on forestry, machineries, harvesting, climatic, agricultural etc. for sustainability and better environment [3].

Economic instruments of policy

Policies and market of any economy is mainly dependent on two factors: supply and the demand of products. In context of bioenergy economy, supply means forest resources such as short rotation plantation, forest residues etc. whereas demand indicates energy producing sectors for instance district heating power plants, consumers and local dealers. In reality, supply and demand work side by side or in another word they are interdependent to each other, if pushed for high demand prices will rise. There are some economic tools which affects the market economy such as taxation, subsidies and energy policies. In Finland, government have subsidy program for investment in biomass while energy taxation is applied for company who uses fossil fuels for heat generation. The demand and supply of a product rely on changes in price and this too depends on changes in quantity and this goes to a certain extent called as elasticity. In order to determine elasticity, this simple formula can be used:

Elasticity = % changes in quantity / % changes in price

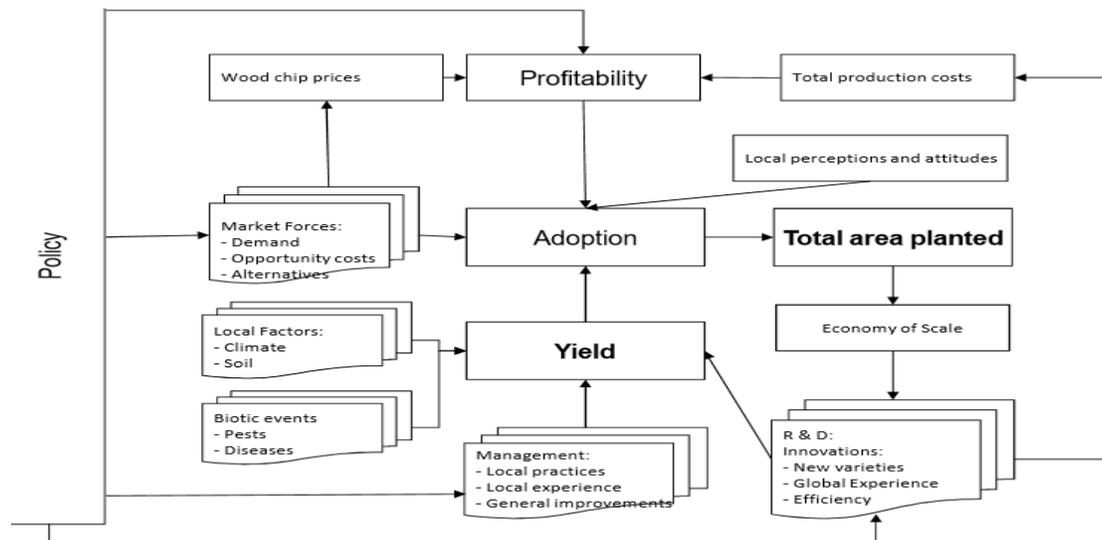
Energy market is one of the important market and has elasticity importance. Elasticity varies from product to product because some are more essential other. In some cases, people have to buy the things no matter how much the price increases for instance oil market because people need it no matter the price. This situation leads to inelastic which can be seen in the curve (a). In contrast, elastic condition arises when there is slight changes in price and this may lead to huge changes in supply or demand of products. This is because of the necessity of the consumer. For instance, changes in price of koff (beer) may lead to huge sales reduction because consumers can still buy similar product karjala (beer). Table: explaining elastic and inelastic demand curve



In fact, energy market tends to be inelastic because of its necessity. There are also conditions such as perfectly inelastic and perfectly elastic in addition to only elastic and inelastic. On the other hand, supply curve shows upward slope which means higher the price will lead to more supply of the goods because producers supply more in higher market price to increase their revenues. In context of bioenergy, different countries have adopted their own energy policy which may include capital subsidies, tax incentives, guaranteed market, eco labelling, promotions etc. Scandinavian countries are ahead when talking about carbon taxation for the better environment [4].

Adoption dynamics in bioenergy markets

Bioenergy market in a global context is no longer a new concept and there have been investment of huge amount of money in R&D as well in industries. Still, bioenergy sector has small percentage of representation in global energy share which are mainly coming from so called " industrialized /developed countries". Studies have found that challenging competition with other forms of energy are caused by non-technical barriers and there have been plenty of projects and investigations to eliminate those barriers for instance an EU-Joule project for non- technical barriers to renewable energy technologies [6]. Bioenergy market adoption varies from country to country and is a perception of people on how they take it. It also relies on dynamics of market such as demand, opportunity costs as well as an alternative force. Below is a picture attached describing several aspects in adoption of bioenergy market and policy effect.



Each country has their own system of market adoption. Sweden has implemented willow as an agricultural crop for bioenergy production during this 20 years' time period thereby establishing more than 14000 ha of arable land. Driving forces behind this successful plantation scheme was a Swedish policy which were implemented after oil crisis in 1970s. By 1980s- 1995, country had already produced their commercial SRP (short rotation plantation) as well as programs for economic and policy incentives. The policy tools were mainly based on subsidies, taxes, promotions and R&D. Similar system were adopted in other countries like UK and Germany (Bavaria) too. In overall those policy programs worked quite well in Swedish case although there was a negative effect of subsidies as farmers did not care enough attention to the plantation once they received the grants. In a similar case, Finland had a big failure in reed canary grass plantation because of high number of plantations, subsidies and expectations [5].

Biomass Markets: model behavior

Market behavior is one of the broad area in economics which includes the behavior of consumer and the business. This also refers to the stock market because some of the buying and selling happens within stock market. The outcome of the market also relies on the behavior of market. Economy of market is mainly shaped by the supply and demand of the goods. For biomass, market can be analyzed based on these three players:

- Forest owner
This is the person who decide to sell /not to sell the wood
- Wood biomass
Mainly dealers buy the biomass and bring them to the energy plants.
- Bioenergy plant
They buy wood for energy production, but they may not buy if higher than the profit with energy

There was an interesting game played in a class about the market behavior. First group of students were pretended to be the forest owners, second and third rows were dealers and the last were the energy companies as well as some were the policy makers. Some situation was created such as unbalanced market price set by the forest owners and ultimate price was hugely different when bioenergy plant received wood. Similarly, policy was invented to control the owners and fixed the price for wood, but dealers were too wise to get more profit. Lastly, there were only limited numbers of dealers left and result were seen how they could control the whole market. Finally, policy makers had to maintain the margin of no more than 20% of profit for dealer as well as different rules for owners were set and result was more balanced. The fun experiment of the classroom clearly showed how one player affect the whole market behavior. This was also leading to monopoly when flow of biomass was more than needed.

There are some factors which may affect the market such as skill and experience of individual agents. They may affect in prices fluctuation. Further, location, amounts and rules/policy also determines the shape of market. In addition, policy should be made so that all the parties get benefit otherwise risk of monopoly increases which was seen in our experiment when only two dealers/wood biomass left, they were trying to create a monopoly. So, market should be controlled by policies so that no one can control independently and in order to that extra vigilance needed which can stop the foul play.

Concepts and approaches to bioenergy governance

Governance is an action or effort in coordinating an organization or a state. This can function as a broader sense than government does because it analyzes all the coordinating system from small operational management to the long- term planning and policy makings. This has many aspects depending upon need of governance either in a local, national or even international. In order to work as a governance, it has to set some rules and social arrangement so that the governance can bind the organizations. There is also international influence of governance in local policy making. There are some frameworks and issues related bioenergy governance. Environmental issue like carbon talk is currently a hot topic in most of the seminars. In addition to that technological issues and market forces are important issues.

Framework for bioenergy governance

Resource tenure
Market
Ethics
Adoption

Resource yield
Policies
Impact
Capacities

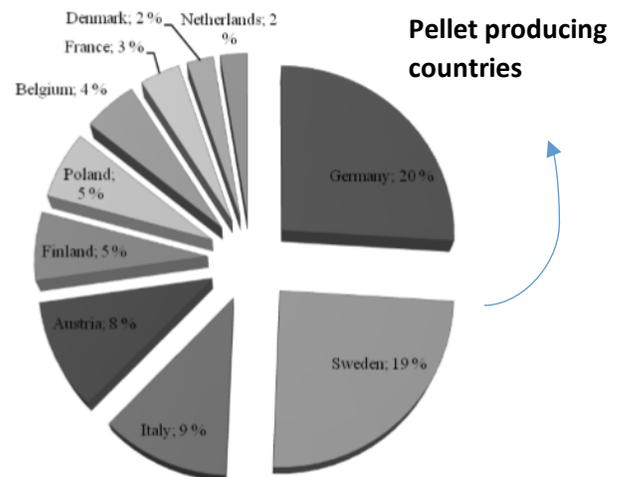
In order to make a better impact on bioenergy, factors such as social acceptance is necessary because this will help to make bioenergy policy and ease to develop governance. Moreover, perception towards bioenergy may take some time or generations because even the people of so called, developed nations do not have knowledge of high level of bioenergy and it can be easily predicted how long will it take for other countries throughout the world. Not even the general public, bioenergy is not the first choice of international forestry students because they are too busy to focus on forest managerial issues and climate change. This situation is further worsened by several conflicts in forestry due to different operational practices. Further, there was strict regulations set on social and environmental sector in 70s decade. J. Arevalo et. al have noted that bioenergy related conflicts are on rise due to increment in number of bioenergy plantations in many countries. In addition, large scale plants are reported in recent years especially in Latin America and south East Asia. There was a claim that development of such bio fuel plants may lead to an extreme deforestation because of the feedstock issue. In those cases, claims were mainly done by non- governmental organizations (NGOs) or the environmental NGOs which are usually formed by environmentalists and general public who can influence the people through campaigns, research as well as through the advocacies. The case study done in Kenya by J. Arevalo group have suggested that, there is an urgent need of tools which can be implemented in a project level in order to eliminate the conflicts regarding bioenergy development. Further, different stakeholders of bioenergy market development need to be maintained.

International bioenergy markets

International bioenergy market involves the trade between countries to countries. This may include many aspects from raw materials imports to products supplies. Couple of products such as pellets and wood chips/wood fuels are commonly traded products in European nations. In recent time, wood pellets have been an increasingly important source of energy for heat and power especially in Europe. This is also a fact that pellets are made small in sizes and contains energy in denser forms. Due to the high demand, supply chain is also increasing so as the pellet production plants. Not only the chips and pellets but also there are increase in biofuel and waste wood consumption. In Finnish case, the consumption of biofuel in road traffic in 2014 was 21.6% which was the highest among all the European nations and there is an obligatory rule of 20% by 2020 [6]. Whereas, total biofuel consumption (data 2004) was around 401 PJ.

The increasing demand of wood pellets have certainly increases the supply chain. Mostly European nations such as Sweden, Germany, and Finland, Austria as well as US and Canada are top producer of pellets. Neighboring Sweden is considered as biggest in terms of consumer and producer of pellets whilst Finland mainly exports due to their small market volume. Furthermore, the chart attached in right side shows the different countries producing pellets:

The main usage of pellets is in a household sector (52%) whereas different scaled boilers uses the rest. There are however changes in production and consumption patterns due to lack of broad statistical research. In addition, Policy is the most important step that most of successful pellet producing countries have implemented. They have used mainly subsidies, tax reduction, green certificate system, feed in premium etc.



Depending upon the countries resources, demand and market availability, they have shaped their profile in bioenergy business. Pellet industry however is more reliant on wood-based industry because wood pellets are nothing other than byproduct of forest industry and mills. It is also considered as new product in many countries and availability in cheaper prices would be beneficial to get initial popularity. This not only makes a country independent in imported petroleum products but also utilizes the local resources thereby reducing the carbon emission. However, challenges still remain in supply and demand in order to develop the new raw materials [6].

Bioenergy Regions

Global debate for sustainability and the need of bioenergy in energy sector are increasing every day so as the renewable energy governance programs. Organizations like EU has set certain regulations and implemented renewable policies so that each and countries can reduce the emissions. Green certification system is one of the encouraging approach which will be given to organizations who produces electricity from renewable sources. The whole idea is to motivate industries to use renewable sources no matter which methods industries would choose. Further, in order to get the certificate, energy production can be either from wind, solar or it can be produced by hydro or biomass [1]. The conversion of biomass into heat, energy and fuels are common in Scandinavian scenarios although there are many possibilities in other applications.

In addition, bioenergy materialization and governance doesn't seem to be a smoothly upgrading as the debate continues to grow because many organizations like NGOs are campaigning the issues such as food vs energy. There are also protests and events rising high to stop the bioenergy mobility. In context of EU, renewable energy policy mobility is done through 3 major processes:

- I. Policy mobility and mutation: The ideas or product developed in one spatial region into the other places in geographically variable ways.
- II. Spatial design of policy: the purpose with this is to make policy consistent but also bit of alterable in order to implement in various context.
- III. EU policy design as a local process: deals with supply of policies throughout the Europe.

The case study in Norway shows that country is aiming to use renewable energy by 67.5% where 10% will be used in transport by 2020. Norway, itself is a rich country in oil in addition to the hydropower which produces huge amount of electricity (95%) in the country which put other forms of energy sources in shadow. There, bioenergy is not as big as in other EU nations because there is no possibility of such rural development or employment opportunities of bioenergy. However, the nation has implemented many different grant systems for wood-based heating system to encourage the locals/entrepreneur to use renewable resources as well as to fulfil the commitments made to organization like EU [7].

Policies and modeling of energy systems for reaching European bioenergy targets

Carbon emission is one of the major environmental challenge that the current world facing and therefore many countries have adopted certain energy policies in order to reduce the carbon amount in air. Bioenergy contributes an important role in renewable and sustainable energy sector for instance, electricity, power, heating and fuel. The fuel needed to produce bioenergy comes from biomass which is derived from the organic sources. According to an estimation made by EU's national renewable energy action plan (NREAP), there will be an increment in usage of bioenergy from 59 Mtoe in 2005 to 135 Mtoe by 2020. In addition, world bioenergy association has predicted that imported bioenergy from biomass and waste products in Europe will cover 20% of final energy consumption and renewable energy resources will cover 45% by 2030 [8]. Those numbers show that EU's policies and goals regarding renewability and sustainability are making a positive effect.

The approach of carbon tax or CO₂ taxation is a policy tool which is also an encouraging factor in promoting alternative energy sources which minimizes the dependency towards fossil fuels for energy. It is calculated based on how much of emissions were made by the usage of coal, oil or natural gases. It is generally calculated as per ton of carbon. This however has a limitation too as there is always a chance that industry's production plants shift from one country to another or continent to continent with no taxation on carbon. This may have a serious an impact on employment sector as well as the country's GDP. Moreover, the action of United nation's 21st annual Conference of the Parties (COP) in Paris agreement on climate change has impacted on carbon markets. Some of the actions are listed below:

- a. Cop21 Paris agreement ratifications
- b. End fossil fuel subsidies
- c. Put a global tax on carbon pollution
- d. Work toward political consensus
- e. Invest in greener technologies

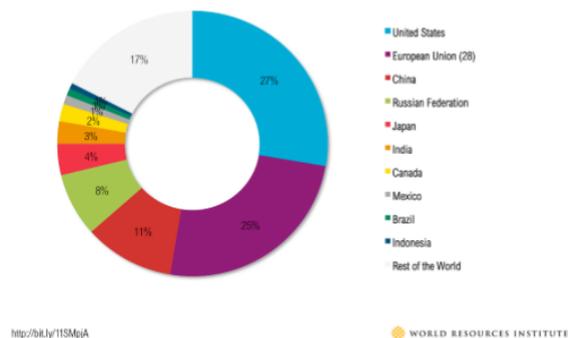
A case study was done whether to invest in CHP or biofuel production plants based on two different policy tools such as carbon tax and biofuel support. The research has figured out that CHP has high carbon cost but low biofuel support whereas biofuel plants need high biofuel support with irrespective of the carbon cost. The technological efficiency in CHP is also comparatively higher (0.85) than the biofuels such as methanol (0.66) and ethanol (0.81).

Bioenergy Policies for EU & Nordic regions

Climate and energy framework for 2030 has set an objective to reduce the greenhouse gas (GHG) emissions by 40% by 2030 as well as reducing global warming level below 2°C when compared to 1990. This includes an estimated 27% of renewable energy in EU will be applied thereby increasing the efficiency up to 30%. Moreover, the policy measures are implemented in order to achieve the set goals (2030) which also supports the EU's GHG reduction plan from 80-95% by 2050 compared to 1990. Currently, Asian countries such as China and India as well as US are the main producers of CO₂ and it may take longer time period for these countries in emission control. However, G20 meeting in China 2016 were able to make signature in Paris climate agreement for top carbon producers China and US.

EU in another hand has taken a step forward in bioenergy sector as they have invested reasonably in R&D, supported in economic instruments (e.g. taxes) and administrative instruments (monitoring and enforcing legislation).

Cumulative CO₂ Emissions 1850–2011 (% of World Total)



Nordic countries have applied subsidy structures to promote the bioenergy so that they can be less dependent on oil. Bioenergy for instance, biofuels have been exempted from taxes in contrast to the fossil fuels where tax rates have been increasing since the energy crisis in 1970s. In order to develop the market, they have used two forms of subsidy schemes: feed in tariff and fixed production subsidy. Feed in tariffs is quite common to Finland and Denmark whereas Sweden and Norway mostly use common greenhouse certificates. In addition, Finland started carbon-based tax starting in 1990s which was then followed by Denmark after two years. Later, Norway also changed its tax structure in 1999 and separated carbon, Sulphur and fuel oil. EU has mainly production subsidy in bioenergy sector and each country decides on which aspects to promote. For instance, Finland supports biomass and peat using power plant for combined heat and power or heat production. In contrast, Sweden started short rotation plantation during 1980s and are still providing subsidies. For a long time, EU has been working on environmental issues which can be seen in their first directives and then second. Again, European commission set energy policy for Europe in 2007 and later climate and energy package also known as 2020 targets. This aims to reduce the GHG and promote in renewable energy and Nordic countries are setting an example in the field of bioenergy.

Recent and future trends in (bio)energy

The world is more surprising than ever and predicting future has become a huge challenge as there are many features today that nobody would have imagined 60 years ago. This is logical to say that bioenergy will be a subject of exploring and preparing for an unknown future because we might see something very special form of energy developed in coming years too. Today, the prices of oil are falling down, and coal's charm has already faded away as other sources of energy has overtaken. Further, many countries are producing new power generation such as solar and wind which are making each and every individual nation more independent on energy.

At present, renewable energy takes place 14% of total energy demand globally whereas electricity contains 23% which leaves a huge space for new power generations (50%). When comparing bio- based energy with other sources, the growth has been quite an average in last three decades. Furthermore, mostly used bio- based energy is solid biomass for heating whilst biofuels and biogas are not that efficient as it was expected or being expected for whatever the reasons. In future, bioenergy can move forward in two different ways depending upon how the business run in coming years. First, it can act as a central product where land/forest will be used in a maximum volume in order to fulfil the feedstock demand for bioenergy industries, but current forest sources may not be well enough to fulfil the demand and hence fast plantations are needed. Secondly, bioenergy can be taken as one of the product among others and this might possibly reduce overuse of forest/land thereby creating sustainability.

More recently, the demand of woody biomass is on rise due to advancement in conversion technologies. Products such as pulp and paper, bio fuels, bioenergy and biochemical are some of the major products. This has led to the increment of energy plants (e.g. eucalyptus) which has been partly replacing natural forest or an agricultural land especially since 90s. It is true that bioenergy is getting more important and this will stay valuable especially in cold countries where solar and winds are hard to get. However, uncertainties in policies and subsidies as well as comparatively higher operating costs than other forms of renewable energy sources are making bioenergy more challenging. International renewable energy agency (IRENA)'s recent project in 2017 has given positive vibes as renewable sourced generated electricity costs are falling down and are getting closer to the fossil-based energy [9]. The main reasons in cost reduction are due to the technological development as well as internationally experienced medium to large level project developers who are actively working around the world. Further, it is expected to be relatively cheaper than the fossil fuels in near future because of increasing trend of solar and wind energy globally.

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Thank you