Ege Üniversitesi Güneş Enerjisi Enstitüsü
BESTMER
Biyokütle Enerji Sistemleri ve Teknolojileri Merkezi

Utilization of residues as bioethanol feedstock Case of Turkey

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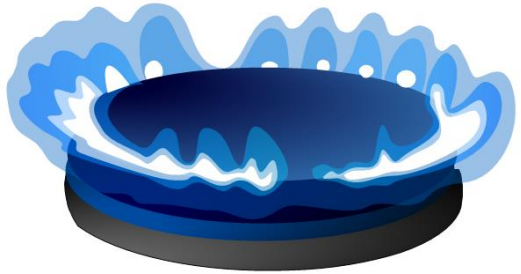
Turkey's Current Status

Turkey is a developing an upper-middle income country according to the World Bank classification. Industry is growing fast and hence more energy is needed.

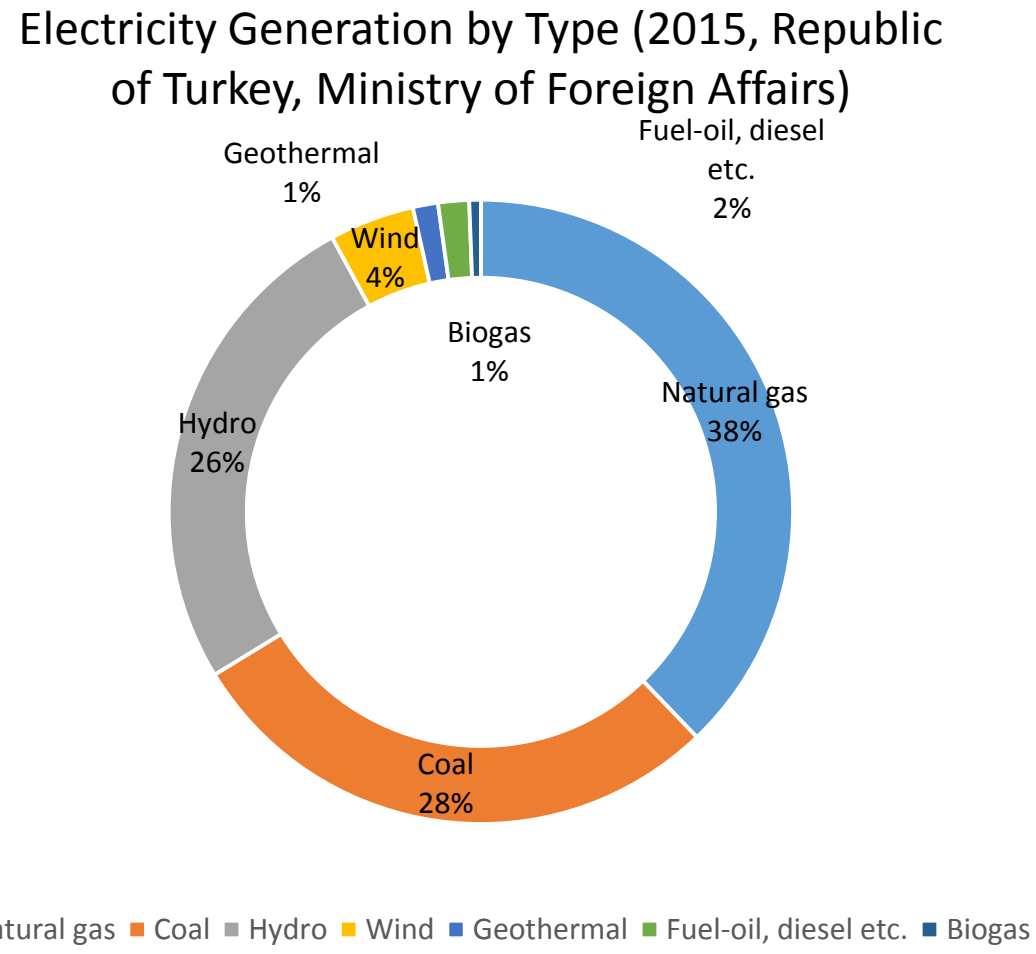
Primary energy consumption from fossil fuels:

petroleum, coal, and natural gas



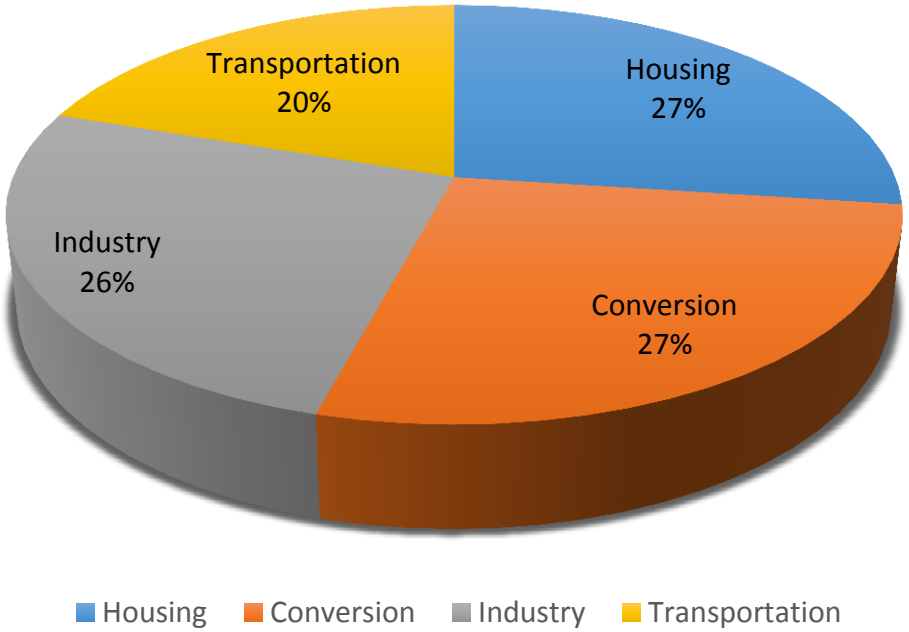
Turkey's Current Status

- Turkey is the highest increasing energy usage country in OECD, and it is mostly foreign-dependent on energy sources; especially in terms of petroleum and natural gas. Electricity is mostly generated by thermal power plants by using coal, lignite, natural gas, and fuel oil. The production of electricity from renewables is small.



Turkey's Current Status

Turkey's Primary Energy Consumption (2015, Republic of Turkey Ministry of Energy and Natural Resources)



- In 2014; however, 49,000 barrel/day of crude petroleum production was performed, and 718,000 barrel/day crude petroleum was consumed

Kyoto & INDCs - Turkey

- 16 February 2005 – 192 countries including Turkey
  - reduce greenhouse gases emissions based on the premise that global warming exists and man-made CO_2 emissions have caused it
- Annex I – privilege for Turkey
- December 2015 – "2015 United Nations Climate Change Conference", which was held in Paris, France as a term "Intended Nationally Determined Contributions (INDCs)"
  - preventing the increasing average global temperature to more than 2 °C
  - reapping the many benefits that arise from a necessary global transformation for clean and sustainable development

Kyoto & INDCs - Turkey

- Turkey's INDCs
  - total greenhouse gas emissions will be reduced up to 21 % by 2030
  - will carry out studies to increase use of waste as an alternative fuel in the appropriate sectors
  - promote alternative fuels and clean vehicles, and reduce fuel consumption and emissions of road transport with the National Intelligent Transport Systems Strategy Document (2014-2023)
  - reuse, recycle, and use of other processes to recover secondary raw materials in order to utilize them as an energy source, or to remove wastes, to recover energy from waste by using processes such as material recycling, bio-drying, bio-methanization
- Turkey announced a reduction in greenhouse gas emissions from 1,175 to 929 million ton CO_2 equal in 2030

Turkey's Current Status

- The Republic of Turkey Energy Market Regulatory and Authority (EPDK) has adopted a course of action regarding using agricultural products as a raw material for biofuel production to promote the local biofuel production and to decrease current deficit. According to this 2013 decision, it is obliged to embed biofuels ever–increasingly from local agricultural products (bioethanol and biodiesel) over the years. Dating from January 1st, 2013, the local content rate in gasoline is going to be 2%, and dating from January 1st, the 2014 local content rate in gasoline is going to be at least 3%.

Turkey's Current Status

- Turkey's population is about 77.5 million, and 19 % of this population is engaged in agriculture.

Crops that used for bioethanol production in 2014 (Tons)

Wheat	Barley	Maize	Sugar beets
19,000,000	6,300,000	5,950,000	16,572,790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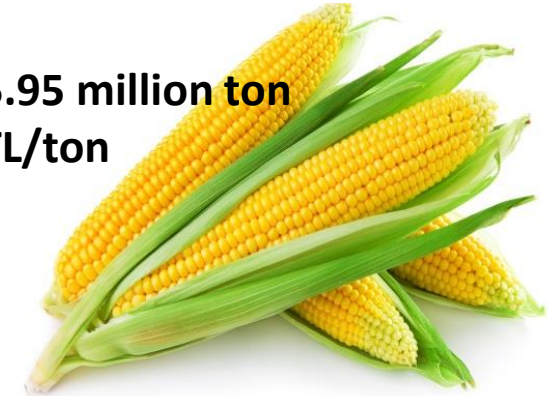
+

+

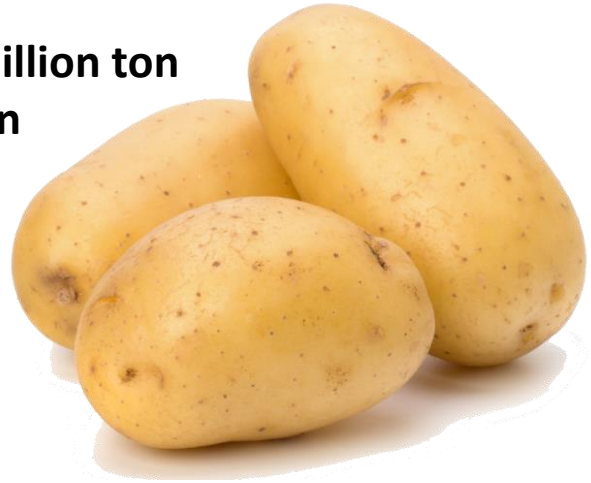
OR


1st Generation Bioethanol

2014 prod. amount= **5.95 million ton**
2015 sell. prize= **696 TL/ton**



2014 prod. amount = **4.2 million ton**
2015 sell. prize = **500 TL/ton**



2014 prod. amount = **830 bin ton**
2015 sell. prize = **2.600 TL/ton**

2014 prod. amount = **16.6 million ton**
2015 sell. prize = **157.50 TL/ton**

2014 prod. amount = **19 million ton**
2015 sell. prize = **865 TL/ton (bread)**
979 TL/ton (pasta)

Challenge of Food vs Fuel

Turkey's Current Status

- Çumra Sugar/Ethanol Factory (Konya-Turkey)
  - 84 million l/year
  - Sugar beet
  - DDGS

- TARKIM (Bursa-Turkey)
  - 20 million l/year
  - Wheat and corn

- TEZKIM (Adana-Turkey)
  - 14 million l/year
  - Wheat and corn

Turkey's Current Status

- Biomass is an important renewable energy in Turkey and its theoretical potential is about 5.66–6.29 Ejy^{-1} . When technical and economic aspects are taken into account, then the potential is about 1.05Ejy^{-1}.

Biomass sources and their potentials

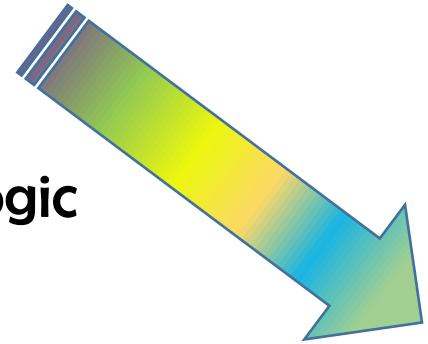
Resource	Raw material potential (million tons)
Municipal solid wastes	25
Wood	3.52
Forestry/wood processing	3.56
Agricultural residues-straw+stalk	13.2
Agricultural residues-seed, shells, wood chips	4
Fertilizer	13.8

24.28 mil.ton

2nd Generation Bioethanol

Challenges of SGB

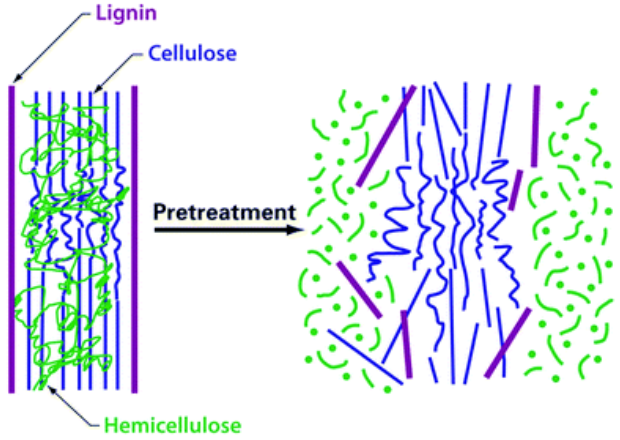
- Pretreatment
  - Physical
  - Chemical
  - Enzymatic/Microbiologic



- Reduce surface of material
- Obtain as possible as carbohydrate
- Minimum waste
- Minimum cost !

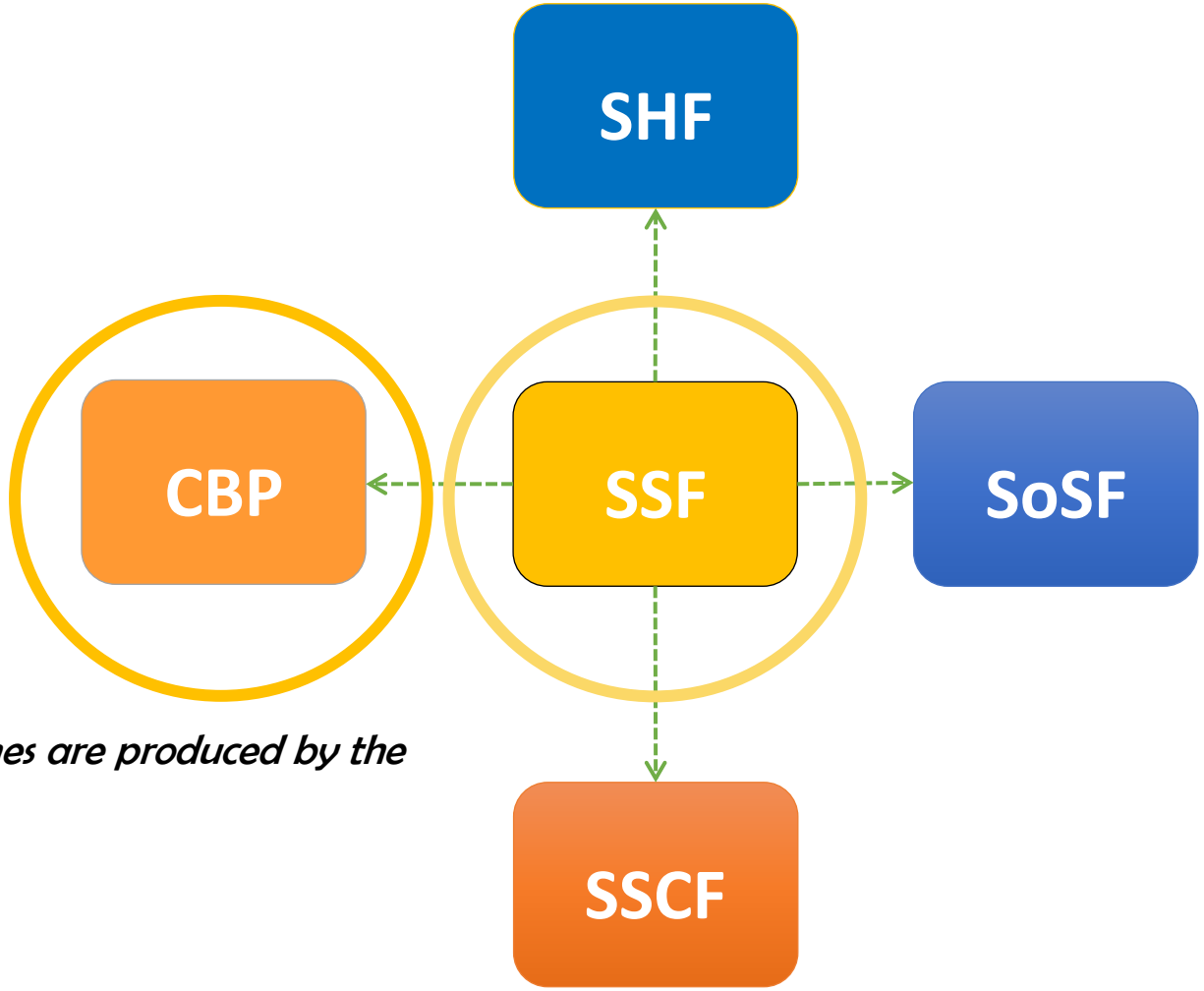
Pretreatment Options

- *Saccharomyces cerevisiae* and other species like *P. stipitis* etc. combination
  - Metabolize different kind of sugars
- Extracellular cellulose system microorganisms like *Clostridium thermocellum*
- Cheap enzymes (low enzyme activity – such as bakery's α-amylase)
- Low lignine, high hemicellulose



Process Options

- To reduce total cost of SGB...



- *SSF = simultaneous saccharification and fermentation;*
- *SHF = separate hydrolysis and fermentation;*
- *CBP = consolidated bioprocessing, i.e. a process in which the enzymes are produced by the fermenting organism;*
- *SSCF = simultaneous saccharification and co-fermentation;*
- *SoSF = solid state fermentation*

Conclusions

- Targets – Short-term
  - Limit to conventional technologies
  - Need a government support program to ensure price competitiveness
  - Support for the private sector participation in bioethanol production
  - Agricultural production and residue control-governmental legal regulations
  - Incentives using bioethanol with gasoline
  - Increasing support to R&D studies about FGB and SGB

Conclusions

- Targets - Long-term

  - Increase at least 10-15 % of usage of bioethanol
  - Incentives for renewable energy investments
  - Public reinvestment of revenues from the ethanol program must occur in the rural areas responsible for its success

Thank you for your attention

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