



# **Innovative Energy Technologies and Opportunities**

**MARMARA RESEARCH CENTER  
ENERGY INSTITUTE**

**Assoc. Prof. Dr. M. TIRIS**

2009

# Presentation Plan

- Energy Supply and Consumption in Turkey (past – present & projected)
- Innovation in Technology
- Incentives for Research
- Sample Projects

# Energy Supply in Turkey (cont'd)

## Total Primary Energy Supply Balance (2007)

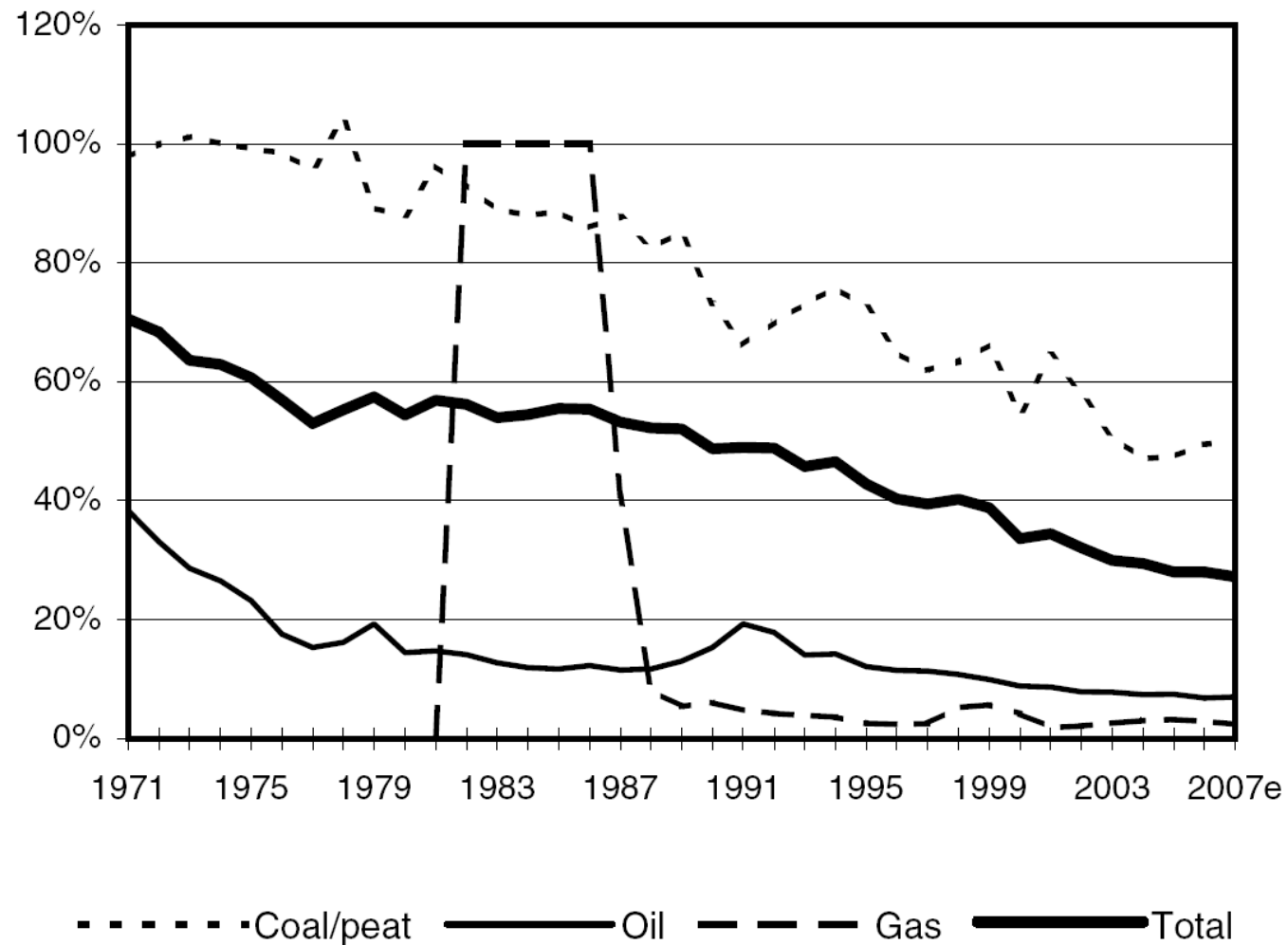
Million tonnes of oil equivalent / Million de tonnes d'équivalent pétrole											
SUPPLY	Coal & peat	Crude oil	Petroleum products	Gas	Nuclear	Hydro	Geotherm. solar etc.	Combust. renew. & waste	Electricity	Heat	Total
APPROVISIONNEMENT	Charbon & tourbe	Pétrole brut	Produits pétroliers	Gaz	Nucléaire	Hydro	Géotherm. solaire etc.	Comb. ren. & déchets	Electricité	Chaleur	Total
Production	14.77	2.15	-	0.74	-	3.08	1.50	5.02	-	-	27.25
Imports	14.92	23.28	14.03	29.78	-	-	-	-	0.07	-	82.09
Exports	-	-	-6.88	-0.03	-	-	-	-	-0.22	-	-7.13
Intl. marine bunkers	-	-	-0.88	-	-	-	-	-	-	-	-0.88
Stock changes	-0.10	0.09	-1.03	-0.08	-	-	-	-	-	-	-1.12
<b>TPES</b>	<b>29.59</b>	<b>25.52</b>	<b>5.24</b>	<b>30.42</b>	<b>-</b>	<b>3.08</b>	<b>1.50</b>	<b>5.02</b>	<b>-0.15</b>	<b>-</b>	<b>100.22</b>
<i>Elec. generated - TWh</i>	<i>53.28</i>	<i>-</i>	<i>8.70</i>	<i>92.77</i>	<i>-</i>	<i>35.80</i>	<i>0.52</i>	<i>0.18</i>	<i>-</i>	<i>-</i>	<i>191.24</i>
<i>Heat generated - PJ</i>	<i>0.74</i>	<i>-</i>	<i>0.90</i>	<i>41.40</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>43.04</i>

Total Primary Energy Supply of Turkey has reached an estimated **100 Mtoe** at the end of 2007

In 2007 Total Amount of Electricity Generated was at an estimated **191 Mtoe**, in addition to **43 Mtoe** of heat generation

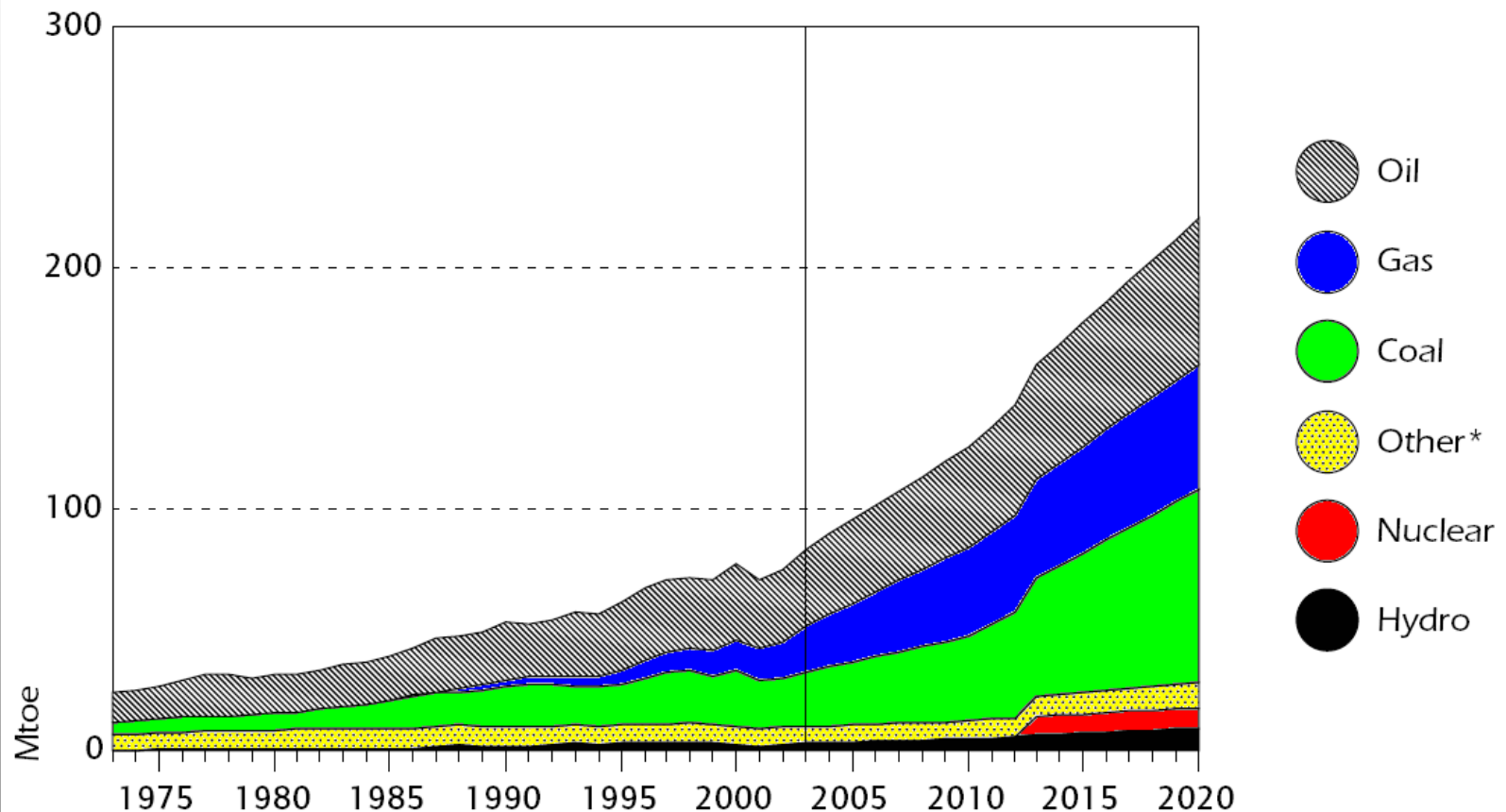
# Energy Supply in Turkey (cont'd)

## Energy Self-Sufficiency in Turkey (1971 – 2007)



# Energy Projection in Turkey

## TPES in Turkey (1973 through 2020)

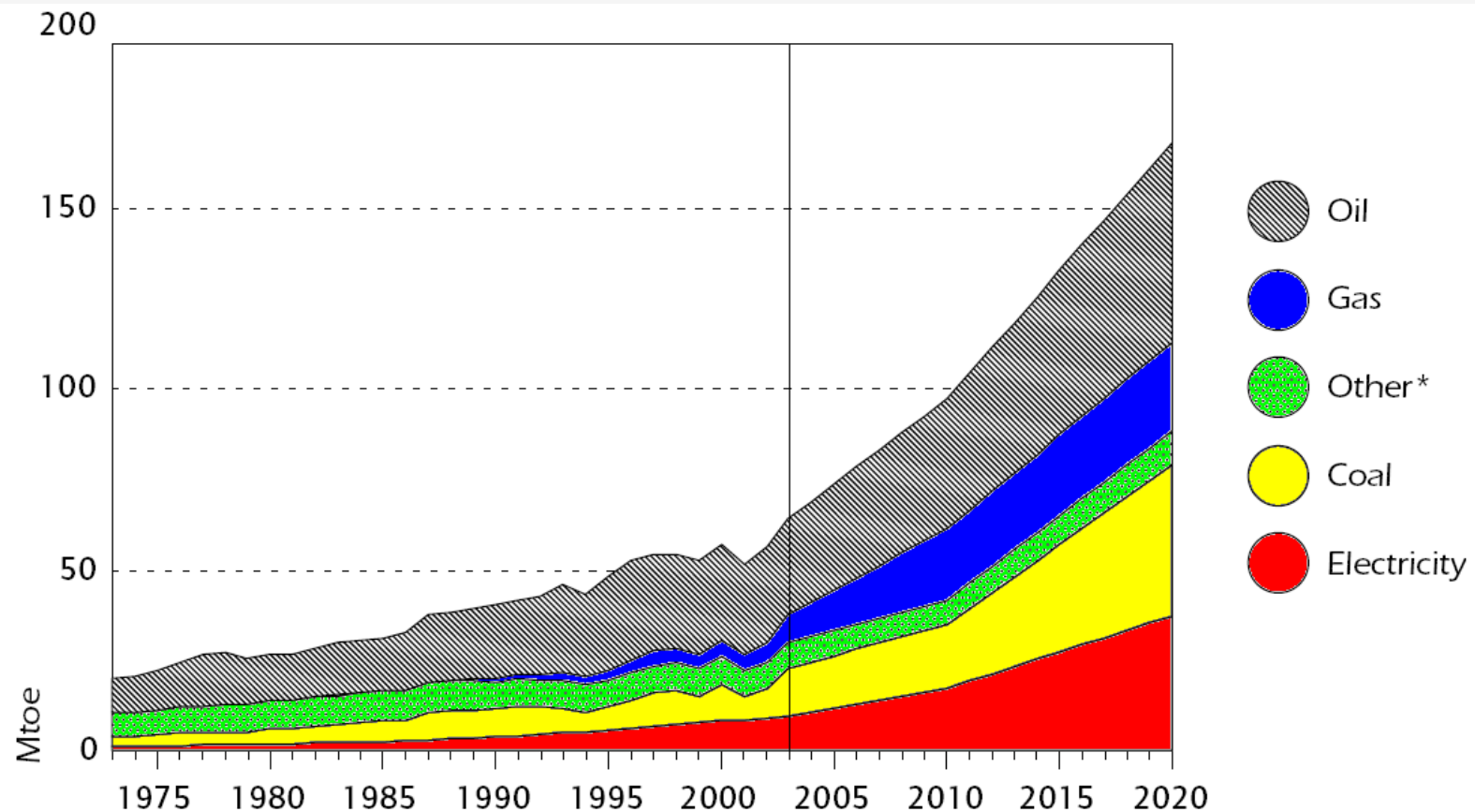


\* includes geothermal, solar, wind, combustible renewables and waste.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

# Energy Projection in Turkey (cont'd)

## Total Fuel Consumption in Turkey (1973 through 2020)

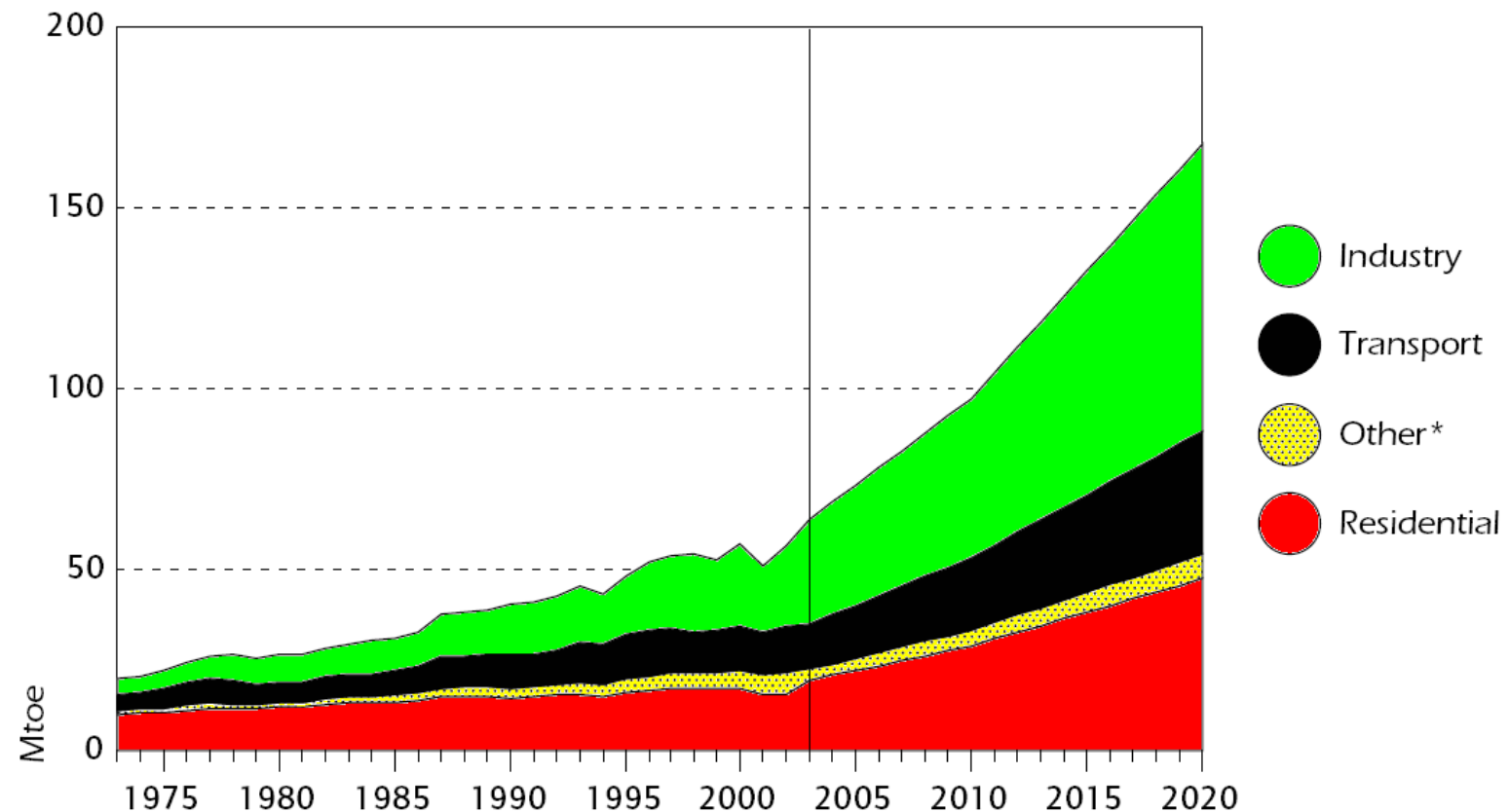


\* includes geothermal, solar, wind, combustible renewables and waste.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.

# Energy Projection in Turkey (cont'd)

## Sectoral Consumption in Turkey (1973 through 2020)



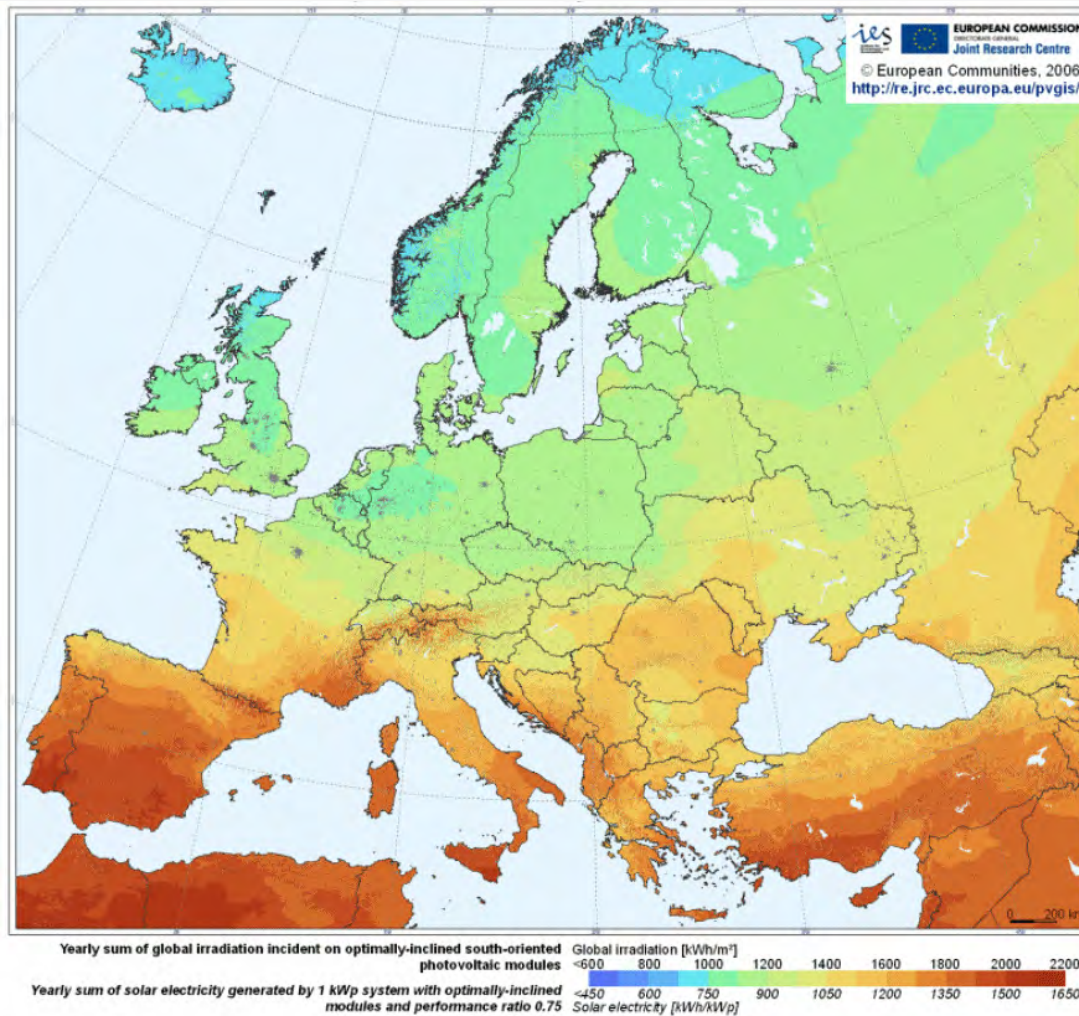
\* includes commercial, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2004; and country submission.



# Solar Energy Potential

## Global Yearly Irradiation Distribution in Europe



**The Solar Energy Potential of Turkey alone is higher than several European countries combined**

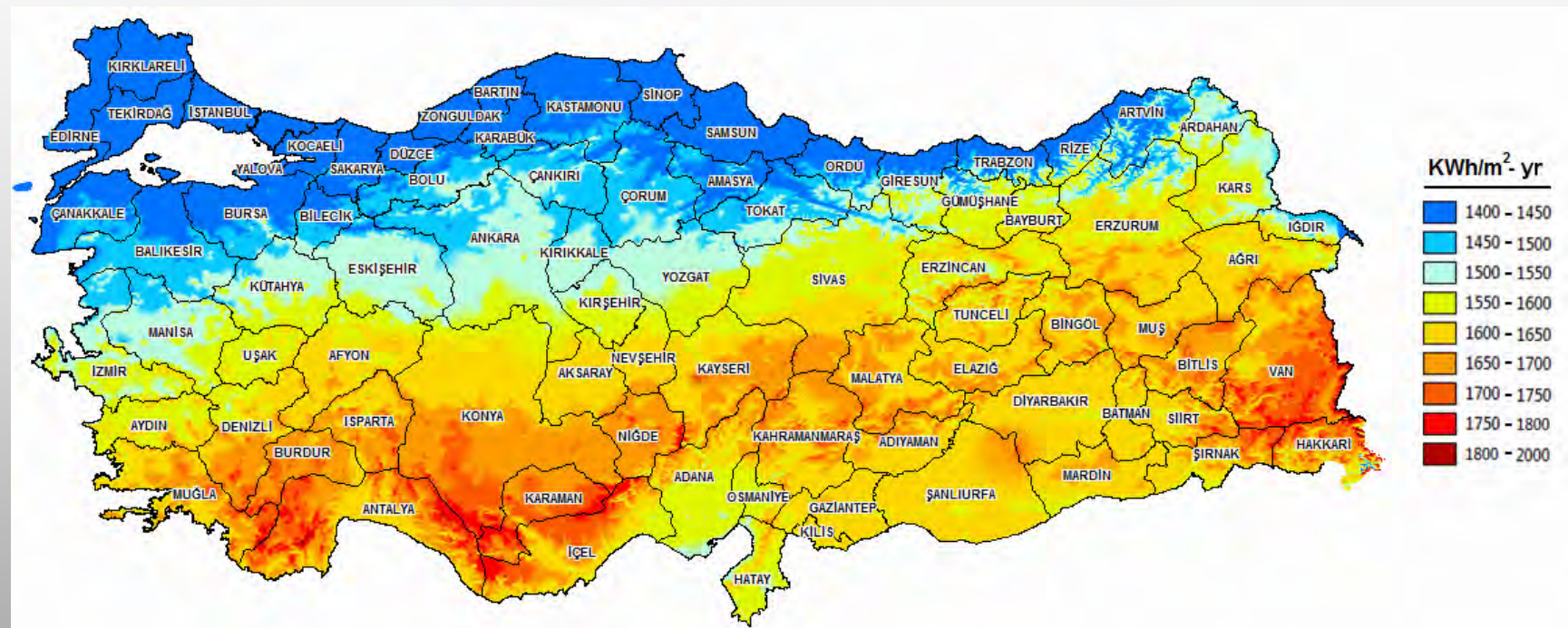
**The average yearly global irradiation value for Turkey is around 1700 kWh/m<sup>2</sup>**

**The same value for Northern Europe is around 1100 kWh/m<sup>2</sup>**



# Solar Energy Potential of Turkey

## Total Yearly Irradiation in Turkey



**The difference in yearly irradiation received between Turkey's Northern part and Southern part is approximately 40 percent!**

# **Solar Energy Research Opportunities**

## **Potential Solar Energy Research Areas**

**Advanced Photo-Voltaic Cells and Modules**

**Concentrated Solar Power Systems**

**Semiconductors, Thin-Film Materials, Biological Collector  
Materials**

**Vacuum Tubes**

**Parabolical Mirrors**

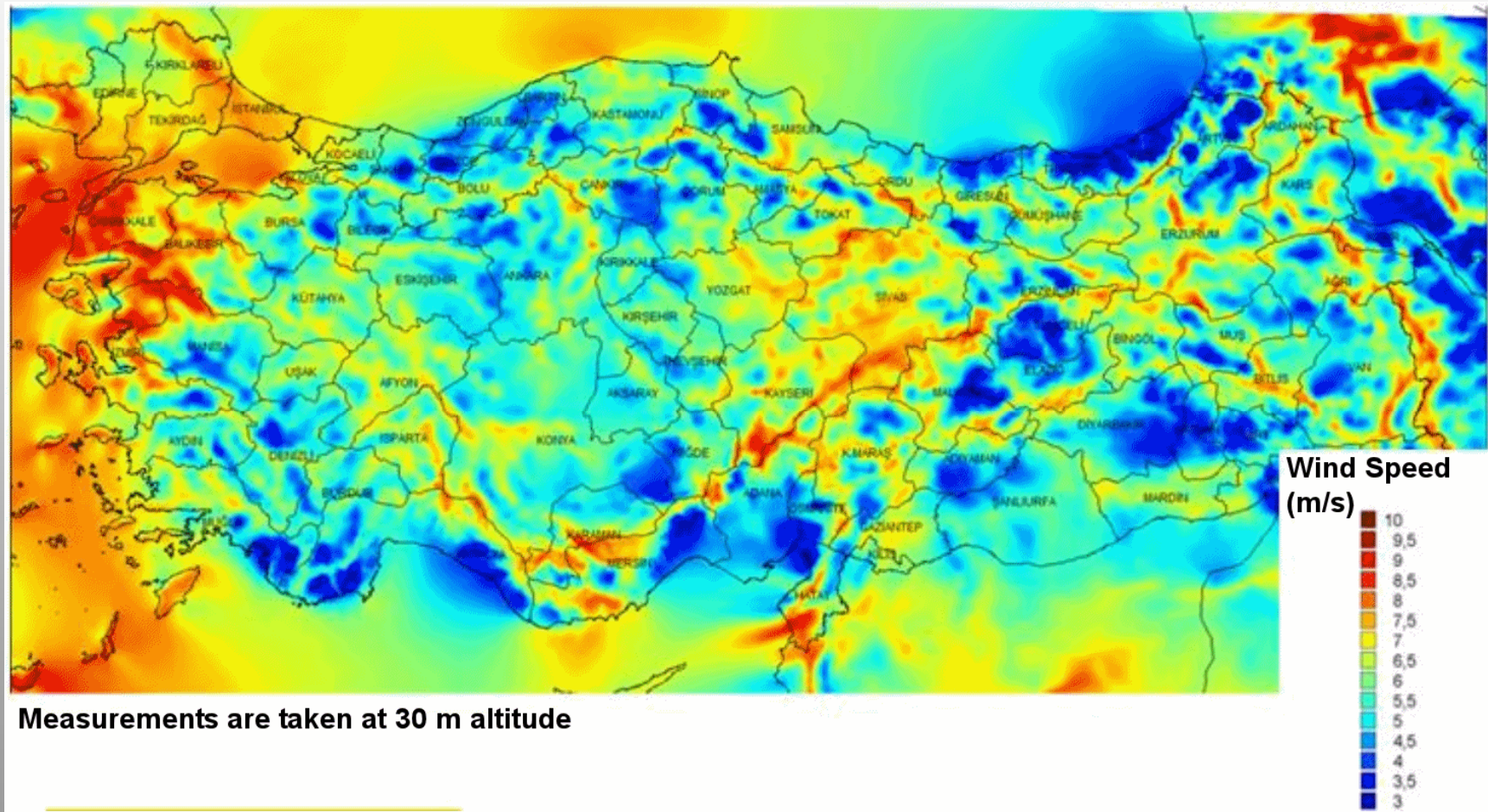
**Solar Tracking, Efficient Arrays and Control Systems**

**Grid Connection Issues**



# Wind Energy Potential in Turkey

## Total Wind Energy Potential in Turkey

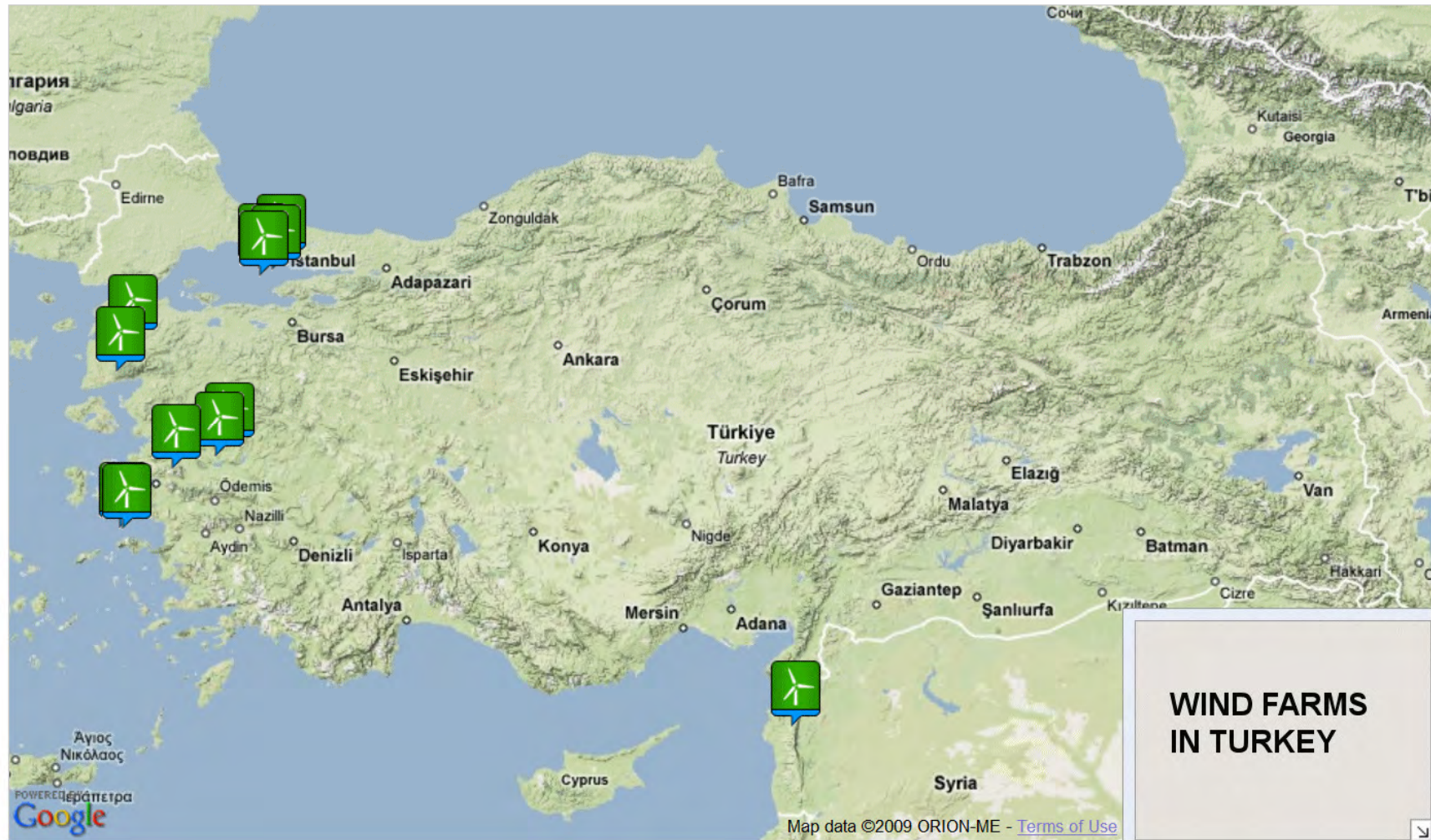


Measurements are taken at 30 m altitude



# Wind Energy Usage in Turkey

## Existing Wind Farms in Turkey



# Wind Energy Research Opportunities

## Wind Energy Research Areas

**Efficient Wind Turbine Design**

**Durable Materials for Rotors**

**Wind Farm Design**

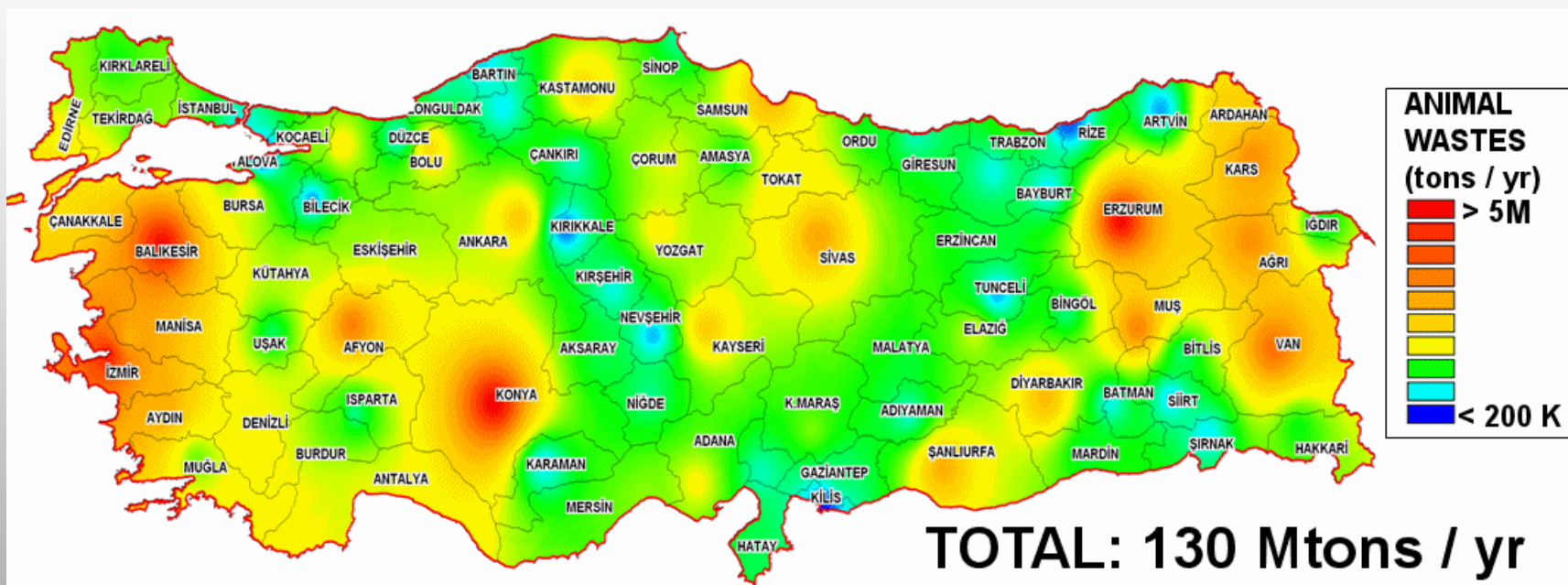
**Off-Shore Wind Turbines**

**Reliability and Sustainability of Wind Energy**

**Grid Connection Issues**

# Biomass Potential in Turkey

## Potential Biomass from Animal Wastes in Turkey

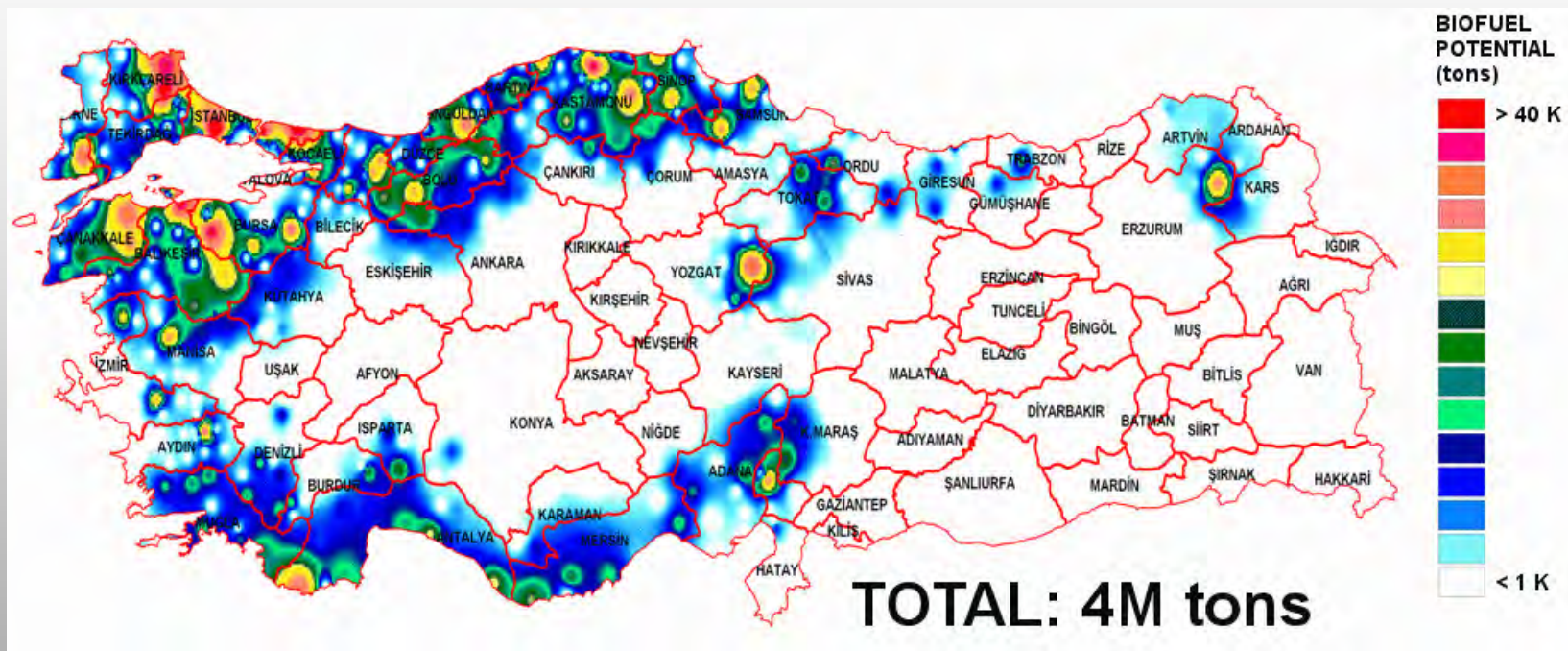


Although the total animal wastes amount to a higher sum, some of the areas in the country are out of reach or not-feasible, therefore not considered in the calculation of the total biomass potential



# Biomass Potential in Turkey (cont'd)

## Potential Biomass from Forests and Forestry in Turkey



The middle and south-eastern parts of the country consist of high plateaus and prairies

The eastern part of the country is mostly mountainous

Source: Turkish Ministry of Energy



# Biomass Potential in Turkey (cont'd)

## Potential Biomass from Agriculture and Orchards in Turkey

	<b>Usable amount of wastes (tons)</b>	<b>Total calorific value (PJ)</b>
Agricultural Biomass	11.8	228.40
Orchards	3.6	74.80
<b>TOTAL</b>	<b>15.3</b>	<b>303.2</b>

# **Biomass Research Opportunities**

## **Biomass-related Energy Research Areas**

**Gasification Systems**

**Efficient Biomass Utilization**

**Biomass to Liquid**

**Biodiesel and Biogas**

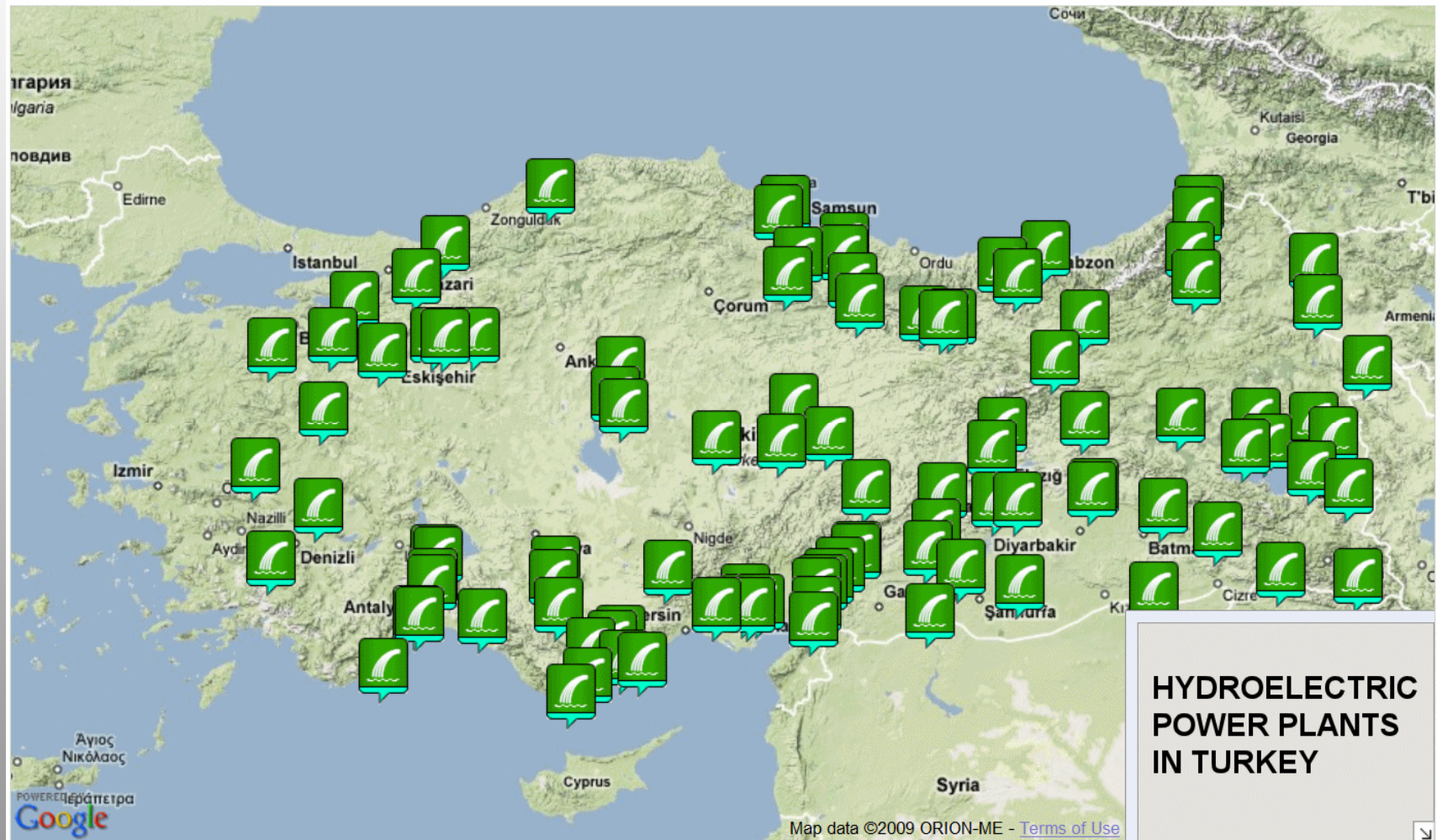
**Second Generation Biofuels**

**Food vs Energy Dilemma**

**Methane Capture**

# Hydro Potential in Turkey

## Hydro-Electric Power Plants in Turkey





ERROR: stackunderflow  
OFFENDING COMMAND: ~  
STACK: