Hydropower versus Other Renewable Energy Sources

World Water Congress XV – Edinburgh, Scotland. 25th to 29th May 2015

EMRE GOK AND ELCIN KENTEL

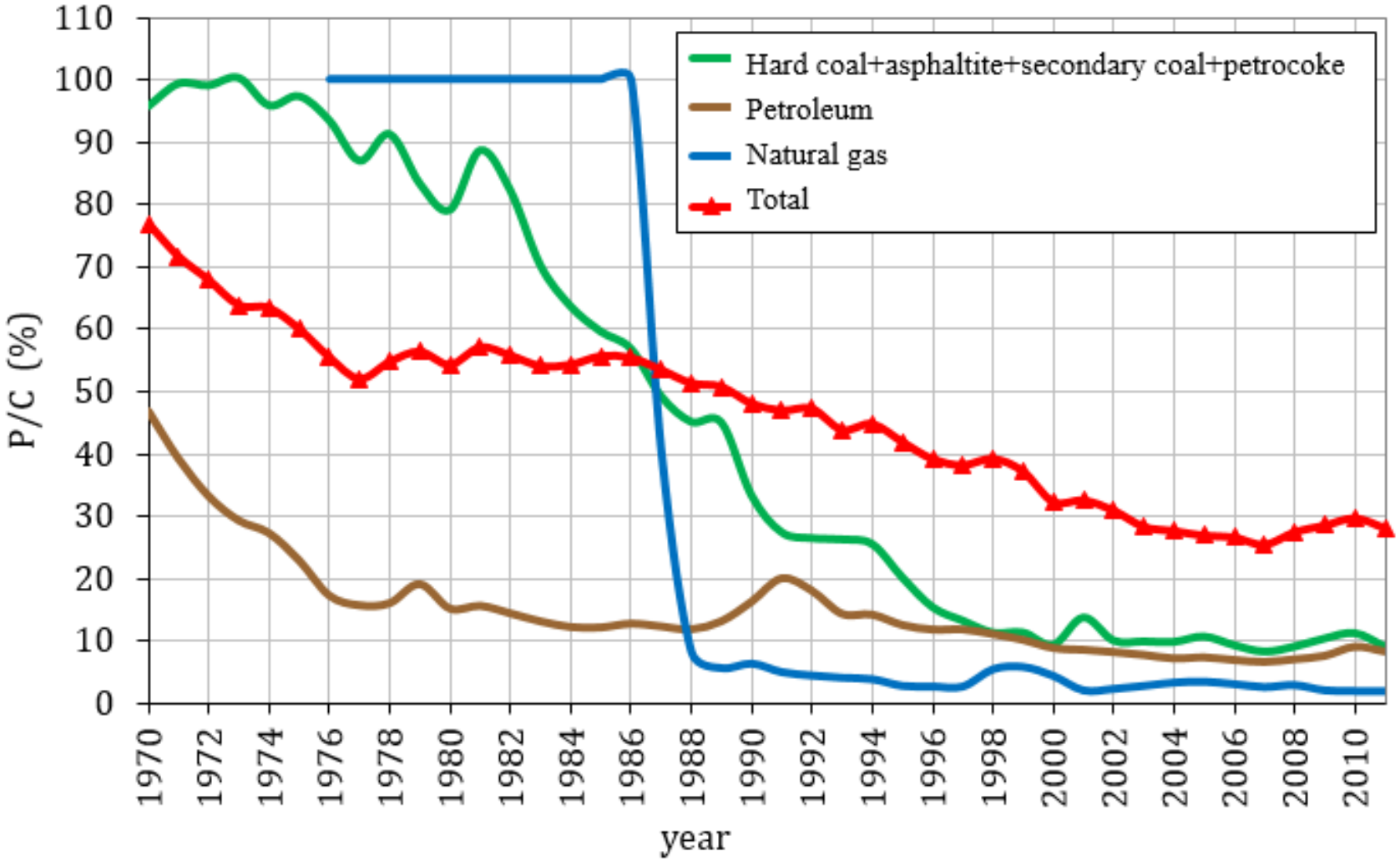
Renewables in Turkey

- Turkey is highly dependent on foreign fossil fuel sources → experiences many problems due to its increasing energy consumption.
- Renewable energy resources need to be developed to
  - reduce vulnerability to disruptions in natural gas
  - maintain economic & sustainable development

Karakaya Dam – Euphrates River

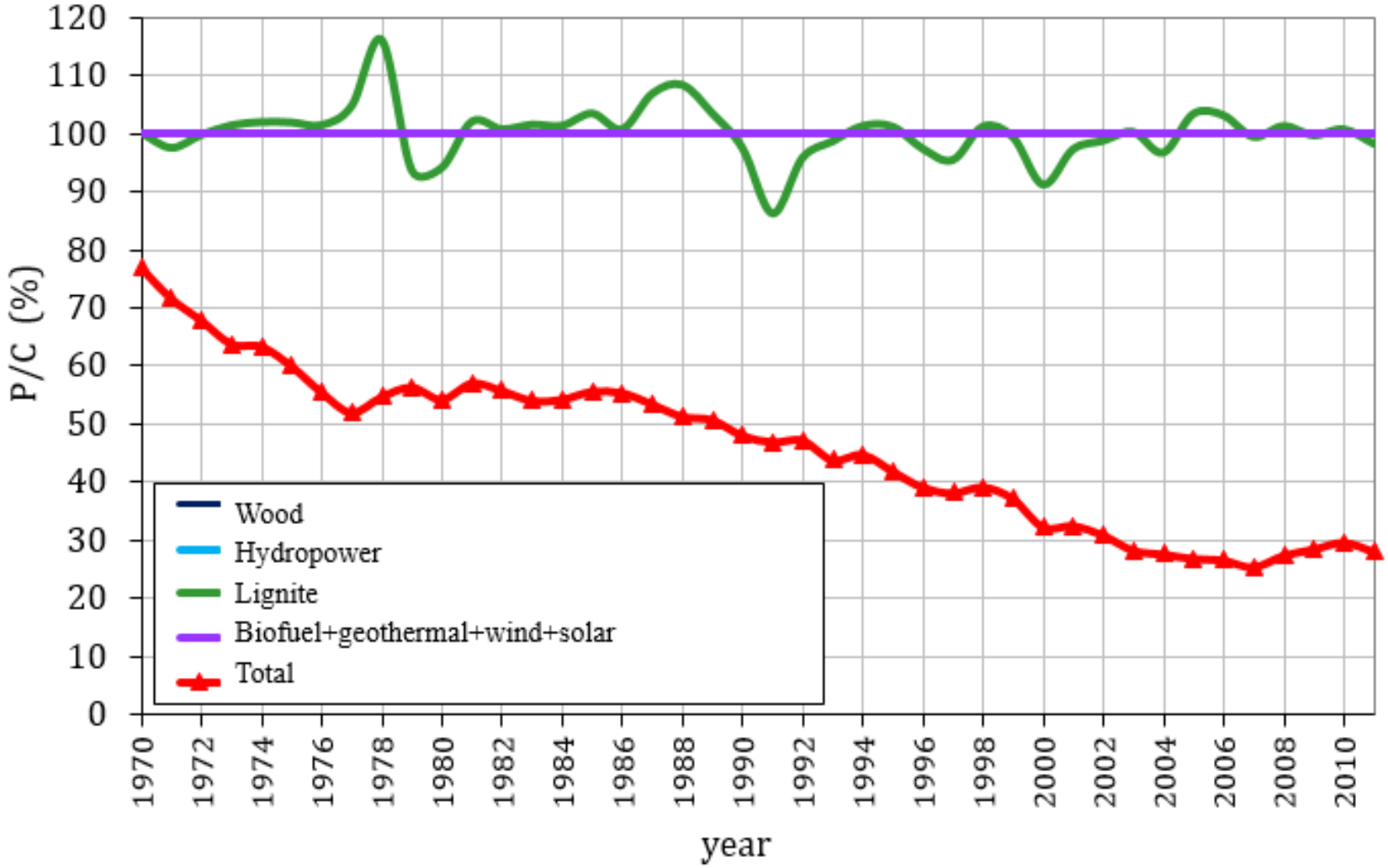
http://tr.wikipedia.org/wiki/Karakaya_Baraj%C4%B1_ve_Hidroelektrik_Santrali

Energy Production to Consumption Ratio for Main Energy Sources from 1970-2011



Prepared by data obtained from ETKB (November, 2013)

Energy Production to Consumption Ratio for Domestic Energy Sources from 1970-2011



Prepared by data obtained from ETKB (November, 2013)

Reserves & Electricity Generation from Renewables

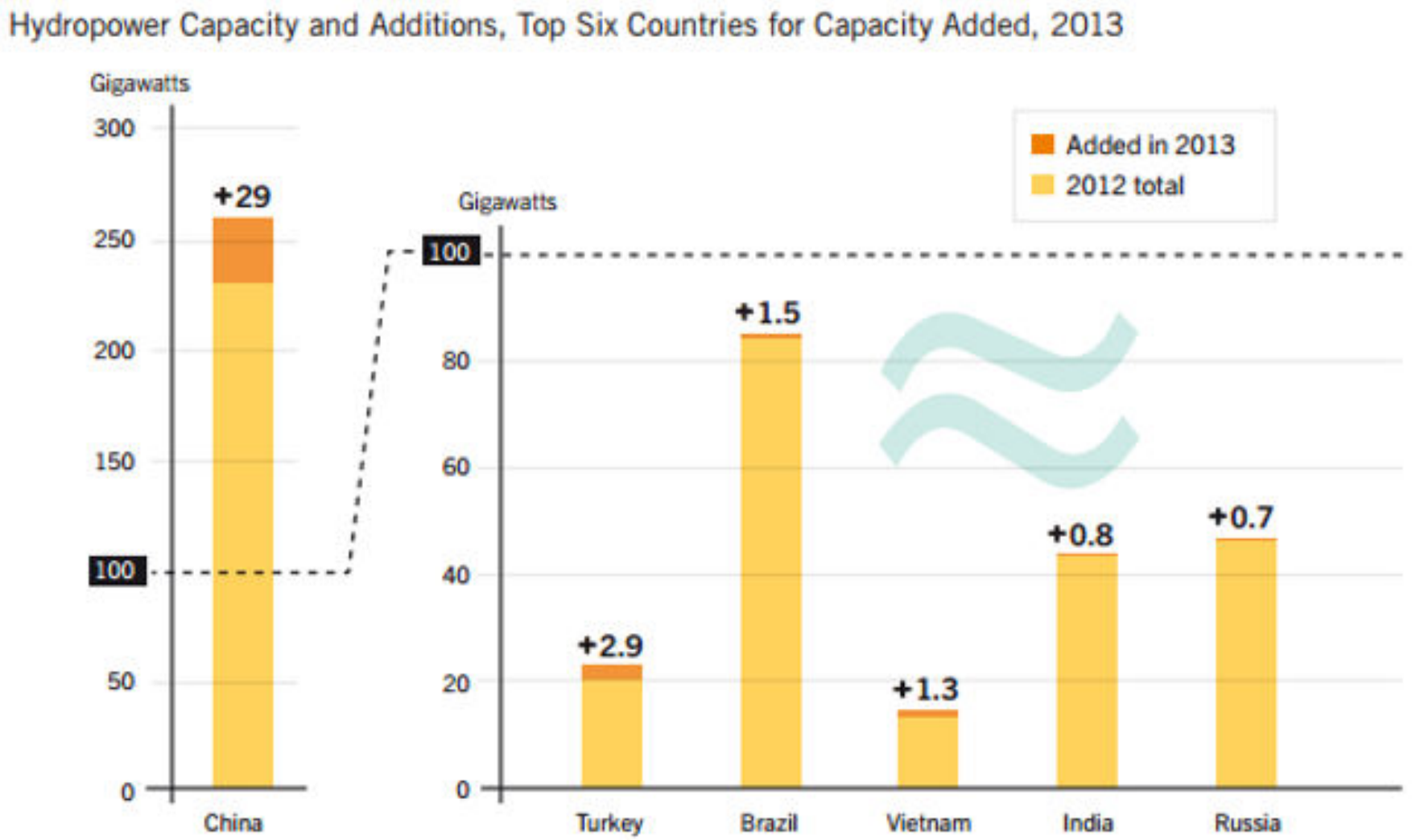
Renewable Energy Source	Potential (10^9 kWh per year)+	Reserve 2011 (MW)**	Installed Capacity in 2011 (MW)*	Electricity Generation in 2011 (GWh/yr)*	Share in Total Electricity Generation in 2011 (%)*
Hydropower	216	36603	17137.1	52.3	22.7
Solar Energy	380	not identified	-	-	-
Wind Energy	150	48000	1728.7	4.7	2.1
Geothermal	9	600	114.2	0.7	0.3

* EUAS (2012)

+ DSI (2013)

** MENR (2012) (geothermal only for electricity)

Hydropower Capacity & Additions in 2013 – the World



Renewable Energy Planning for Electricity Consumption –

MSc. study conducted by Emre Gök

- Goal → prioritization of the development of renewable energy sources, namely hydropower, solar, wind, geothermal & biomass, to increase their contribution to electricity generation of Turkey using the Analytic Hierarchy Process

- Renewable energy sources are compared with respect to selected criteria & sub-criteria by a group of experts who are mostly academics & professionals working in government offices.

http://www.bilgin.com.tr/bares.asp?ide=bandirma

Renewable Energy Planning for Electricity Consumption

- Energy is central to sustainable development which affects economic, social, & environmental well-being for today & tomorrow.

- The major renewable energy sources of Turkey are
  - solar energy,
  - biomass energy,
  - geothermal energy,
  - wind energy, &
  - hydropower.

http://www.guris.com.tr/TR,53/jeotermal-santralleri.html

Energy & Environmental Goals

Renewable energy sources of Turkey are assessed using two main criteria

Energy Goals

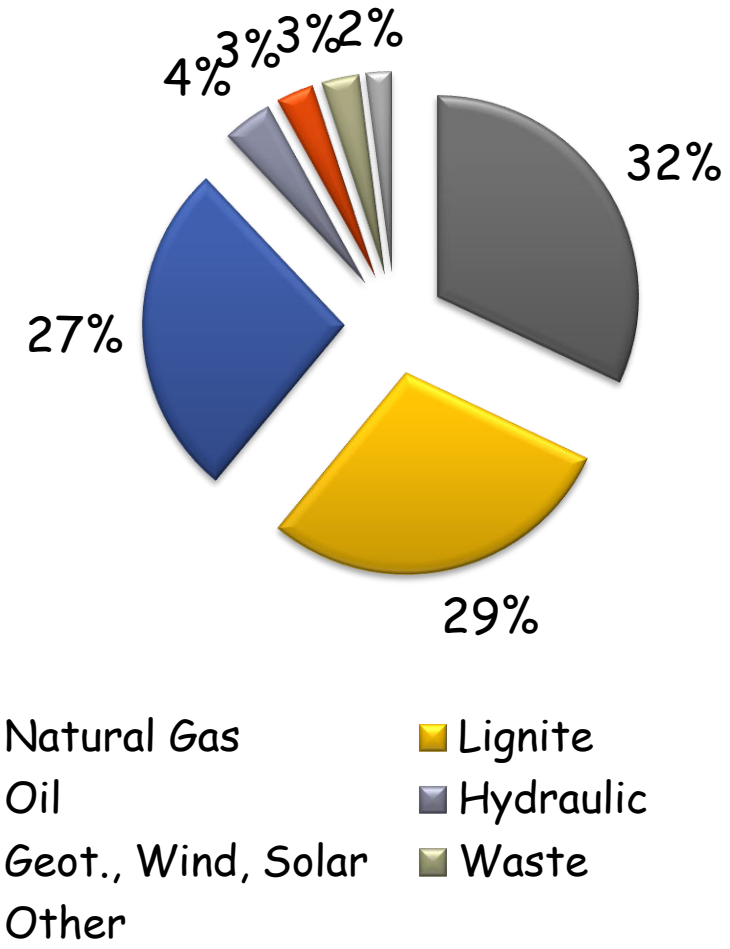
(i) maintaining security for electricity supply,
(ii) supplying electricity with low prices,
(iii) maintaining stability for electricity generation,
(iv) maintaining economic development.

Environmental Goals

(i) maintaining low carbon, SO_x, and NO_x emission,
(ii) maintaining environmental sustainability,
(iii) minimum impact on public health,
(iv) maintaining social acceptability.

Energy Goals

1) Maintaining Energy Security



The Turkish energy sector is highly dependent on fossil fuels.

In 2011, 78.6 % of Turkey's energy demand was supplied through imports (WEC, 2012).

Thus, the electricity sector is vulnerable to the price fluctuations & exposed to security threats such as

- supply disruptions,
- associated economic, social, and health problems,
- international conflicts, & political disputes.

Energy Goals

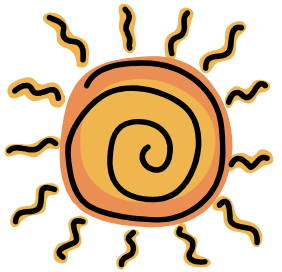
2) Supplying Electricity with Low Prices

Electricity is an important economic input for

- residential,
- industrial,
- agricultural,
- transportation &
- other sectors

In order to maintain high living standards, & national competitiveness, electricity prices need to be low.

Energy Goals



3) Maintaining Stability for Electricity Generation

A common drawback of renewable energy sources is the unpredictable and intermittent output of electrical power.

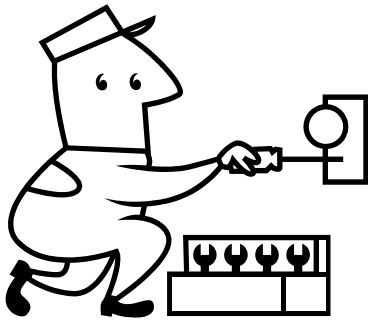
- non-controllable variability,
- unpredictability, and
- dependency on sources that are location dependent

Energy Goals

4) Maintaining Economic Development

Renewable energy technologies contribute to economic development in many ways, especially through

- creating new job opportunities and
- supporting development of local economies.



Environmental Goals

1) Maintaining Low Carbon, SOx, NOx Emissions

Life-cycle GHG emissions of renewable energy sources are much lower than those of thermal sources such as lignite, natural gas and coal.

However life-cycle GHG emission among different renewable energy sources show variation as well; biomass & solar PV emissions are higher than those of hydro & wind.

Power plant	Life-cycle GHG emissions (g CO_2/kWh)		
	Minimum	Mean	Maximum
Lignite	800	1100	1700
Coal	760	1000	1280
Oil	520	780	1200
Natural Gas	440	560	780
Nuclear	3	10	24
Hydro	1	10	34
Wind	8	14	30
Solar PV	43	56	73
Biomass	35	70	99

Environmental Goals

2 & 3) Maintaining Environmental Sustainability & Maintaining Social Acceptability

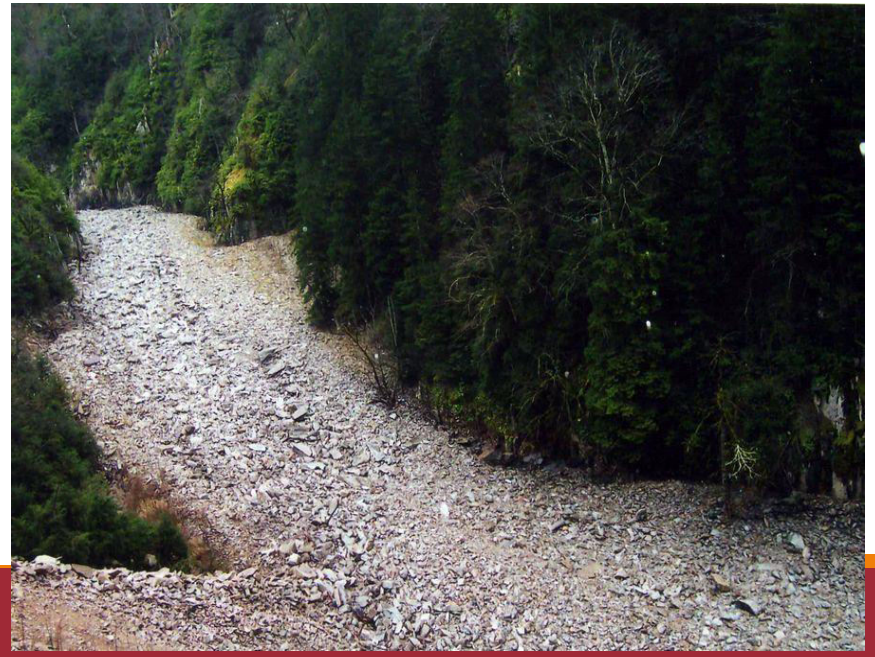
Protests at Rize

Environmental Goals

2 & 3) Maintaining Environmental Sustainability & Maintaining Social Acceptability

Before

After



In Turkey, there is a legal requirement enforced by the Ministry of the Environment and Urbanization (formerly Ministry of Environment and Forestry) to complete an EIA study for HEPP projects with installed capacities of 25 MW or larger. Projects with installed capacities between 0.5 MW and 25 MW are subject to the Selection and Elimination Criteria. The owner prepares a "Project Presentation File" and the Ministry of Environment and Urbanization decides whether an EIA is required or not (MOEU, 2008). Currently, around 2000 SHPPs are planned throughout Turkey (Özalp et al., 2010). Although planning, construction and operation of these hydropower plants must be realized in accordance with the submitted project presentation files or EIA reports, currently appropriate auditing of these studies cannot be carried out by the government since the necessary organizational infrastructure is not fully established yet (Abay et al., 2010). This has resulted in many lawsuits and suspension of executions related with hydropower projects in Turkey. The Eastern Black Sea Region is among the problematic areas in terms of the development of small hydropower in Turkey.

Kentel, E. and Alp, E. (2014) Hydropower in Turkey: Economical, social and environmental aspects and leagal challenges. Environmental Science and Policy, 31, 34-43.

Environmental Goals

4) Minimum Impact on Public Health

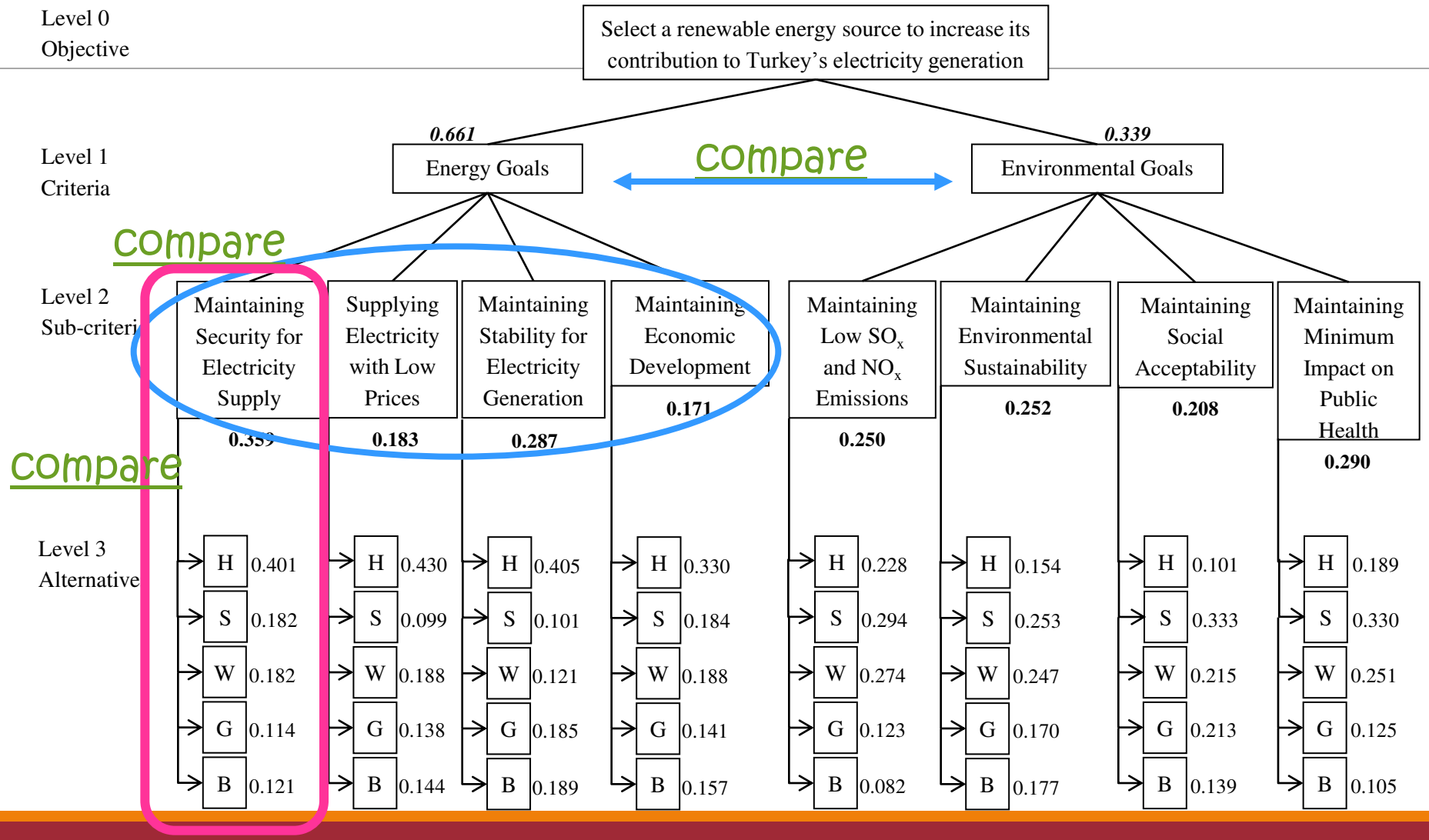
- The switch from fossil fuel electricity generation to electricity generation from renewables has the potential to deliver appreciable health benefits
- but renewable energy sources may have some negative impacts on public well-being such as noise, visual impacts, & indirect health impacts of GHGs.

Method

- To evaluate the major renewable energy sources of Turkey, a survey was prepared.
- The survey was conducted only with "experts".

Number of Experts	Employer
10	University
4	General Directorate of Renewable Energy (YEGM)
4	World Energy Council - Turkish National Committee (DEK-TMK)
2	Ministry of Energy and Natural Resources (ETKB)
1	Energy Market Regulatory Authority (EPDK)
1	Turkish Electricity Transmission Company (TEİAŞ)
1	General Directorate of Mineral Research and Exploration (MTA)
1	General Directorate of State Hydraulic Works (DSİ)
1	Ministry of Development
3	Private Sector
1	Editor of an Energy Journal

Method: AHP – Hierarchy Structure

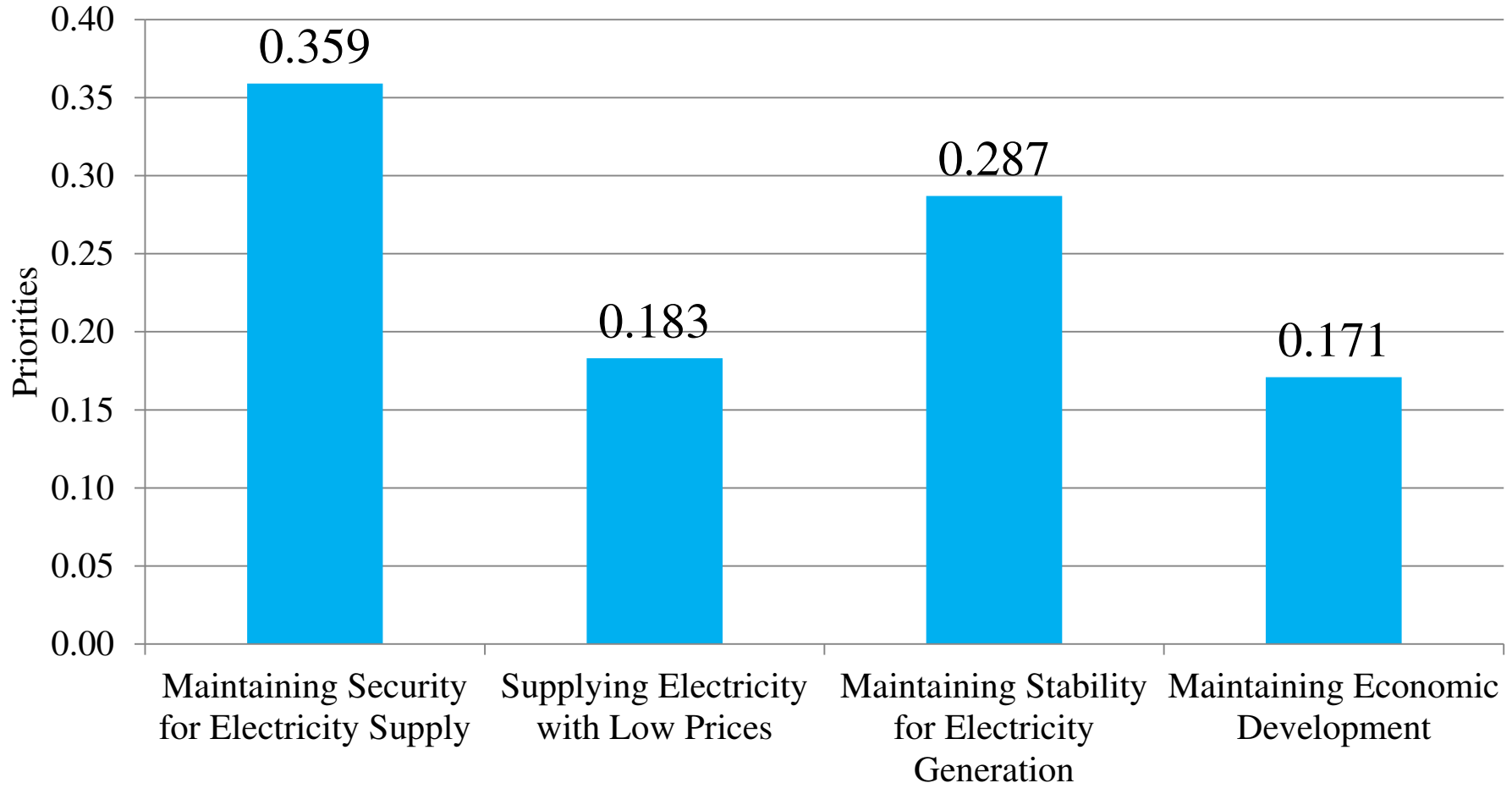


H: Hydropower, S: Solar Energy, W: Wind Energy, G: Geothermal Energy, B: Biomass Energy

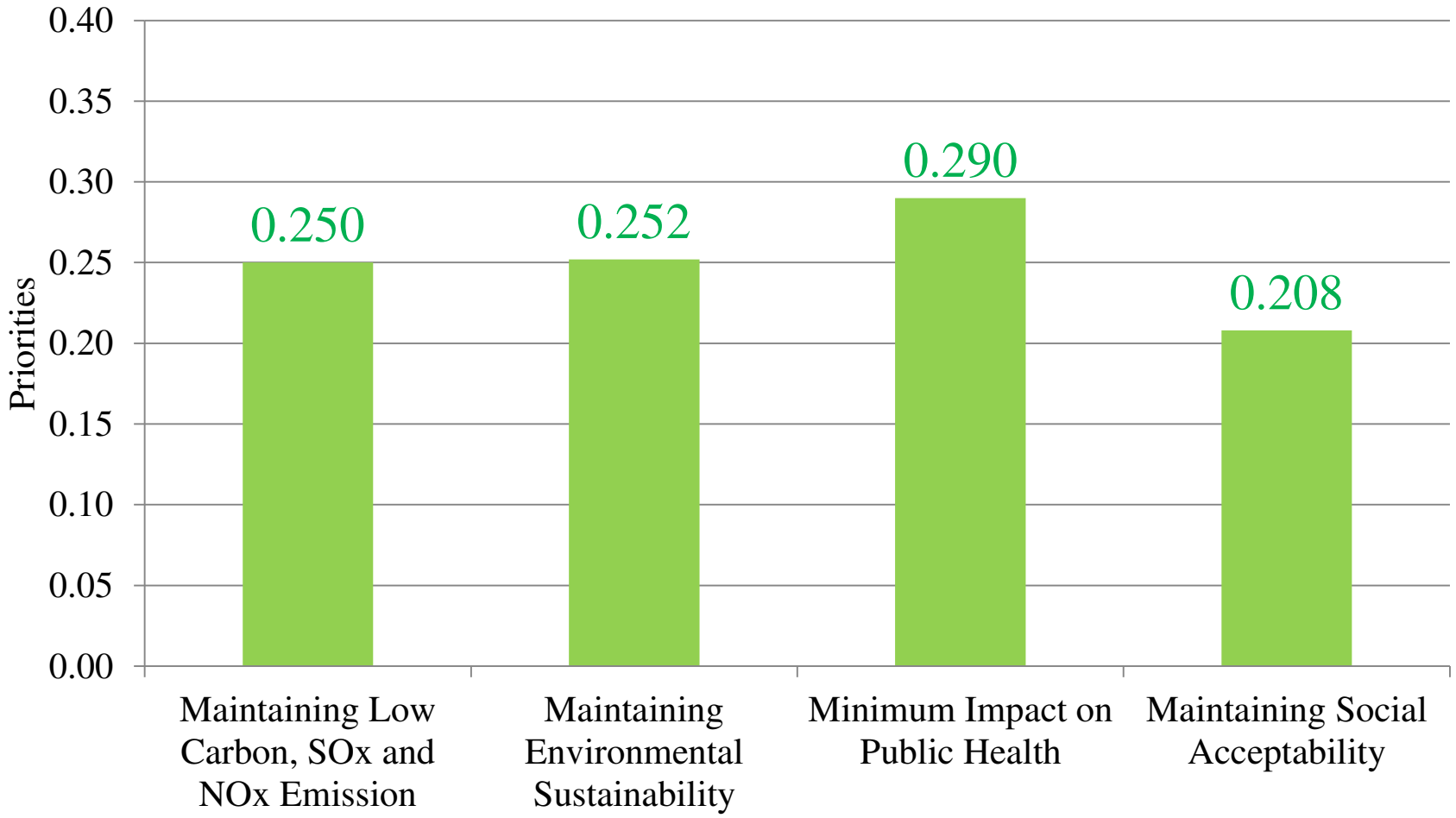
Results

- Energy Goals are ranked as more important than Environmental Goals by the experts.
- The main reason of this preference → energy is required for basic human needs such as lighting, cooking, health services, mobility and communication → Secure & stable electricity with low prices is necessary to meet economic development & improve human welfare & health.
- However development & improvement can be sustainable only if they are maintained without violating future generations' ability to meet their needs.
- Attaining sustainable development requires eliminating those externalities that are responsible for natural resource depletion and environmental degradation (OECD, 2001).

Priorities of sub-criteria of Energy Goals



Priorities of sub-criteria of Environmental Goals



Results

- Hydropower is selected as the most preferred renewable energy source followed by solar and wind energies to increase their contribution to electricity generation in Turkey.
- In terms of energy goals, hydropower performs best due to
  - its untapped potential,
  - providing electricity with low prices, and
  - its potential for generating electricity in a stable manner in hydropower plants with reservoirs.

Results

- However, in environmental aspects, performance of hydropower is not good:
  - Forcing population displacement,
  - loss of cultural heritage assets,
  - the large land requirement of hydropower plants with big reservoirs &
  - negative impacts of run-of-river hydropower plants on local people, nature & habitat.

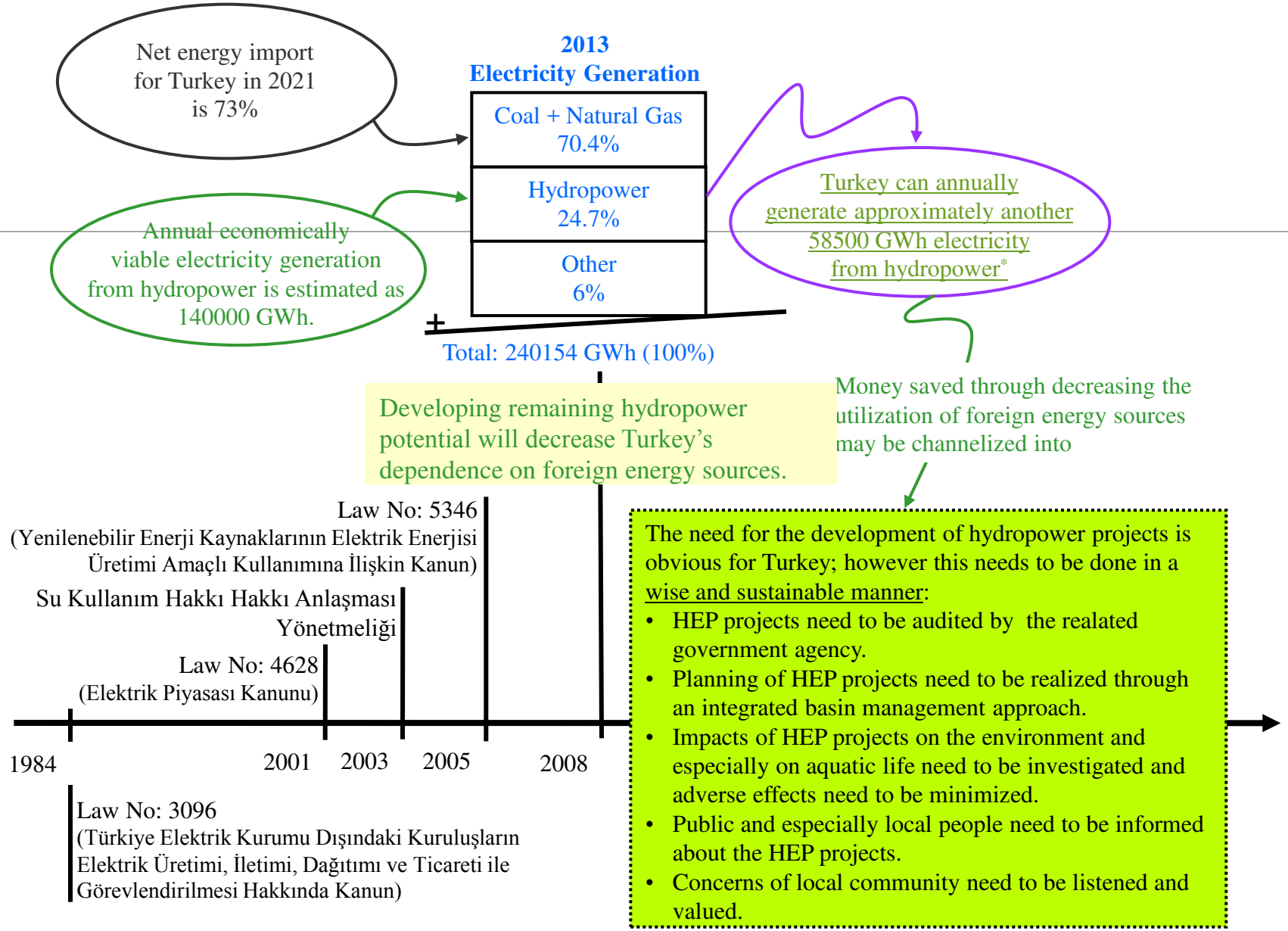
Results

- Both solar energy & wind energy performed very well for Environmental Goals. However, since their performances for Energy Goals are not as high as that of hydropower, they ranked second and third overall.
  - Stability for electricity generation is a critical problem both for solar energy and wind energy → Implementation of hybrid systems.
- Solar energy performed the best for Environmental Goals. The main problem identified by the experts is the high cost associated with solar energy.

Comments

&

Questions



http://www.teias.gov.tr/FaaliyetRaporlari/Faaliyet2013/TEIASFAAL2013INGILIZCE.pdf
http://data.worldbank.org/indicator/EG.IMP.CONS.ZS/countries

PRODUCTION AND CONSUMPTION OF ELECTRICAL ENERGY IN TURKEY 2012-2013

	2012		2013		Increase
	GWh	%	GWh	%	%
Thermal	174.871,7	73,0	171.812,5	71,6	-1,7
Hydraulic	57.865,0	24,2	59.420,5	24,8	2,7
Geo+Wind	6.760,1	2,8	8.921,0	3,7	32,0
GROSS PRODUCTION	239.496,8	100,0	240.154,0	100,0	0,3
IMPORTATION	5.826,7		7.429,4		
EXPORTATION	2.953,6		1.226,7		
GROSS CONSUMPTION	242.369,9	1,0	246.356,6		1,6

BREAKDOWN OF ELECTRICAL ENERGY PRODUCED IN TURKEY BY PRIMARY ENERGY RESOURCES 2012-2013

	2012		2013		Increase
	GWh	%	GWh	%	%
Coal	68.013,1	28,4	63.786,1	26,6	-6,2
Liqued Fuels	1.638,6	0,7	1.738,8	0,7	6,1
Natural Gas	104.505,5	43,6	105.116,3	43,8	0,6
Renewable + Waste + Waste heat*	714,5	0,3	1.171,2	0,5	63,9
Hydraulic	57.865,0	24,2	59.420,5	24,7	2,7
Geo+Wind	6.760,1	2,8	8.921,0	3,7	32,0
TOTAL	239.496,8	100,0	240.154,0	100,0	0,3

*Electricity via waste heat has been produced in 2013