

Turkish **renewable energy** vision 2023 and Applied technological research activities of TUBITAK MRC Energy Institute

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TUBITAK Marmara Research Center Energy Institute

EU-Eastern Partnership STI Cooperation in
Addressing Energy Research and Innovation
Policy Stakeholders Conference

October 12-13, 2015 - Minsk/Belarus

Outline

- **Turkish Energy Vision**
- **Current Domestic Market Situation**
- **Research Priorities**
- **Applied Technological Research Activities of TUBITAK MRC Energy Institute**
- **FP7 Projects & International Co-operations**



Turkish energy vision

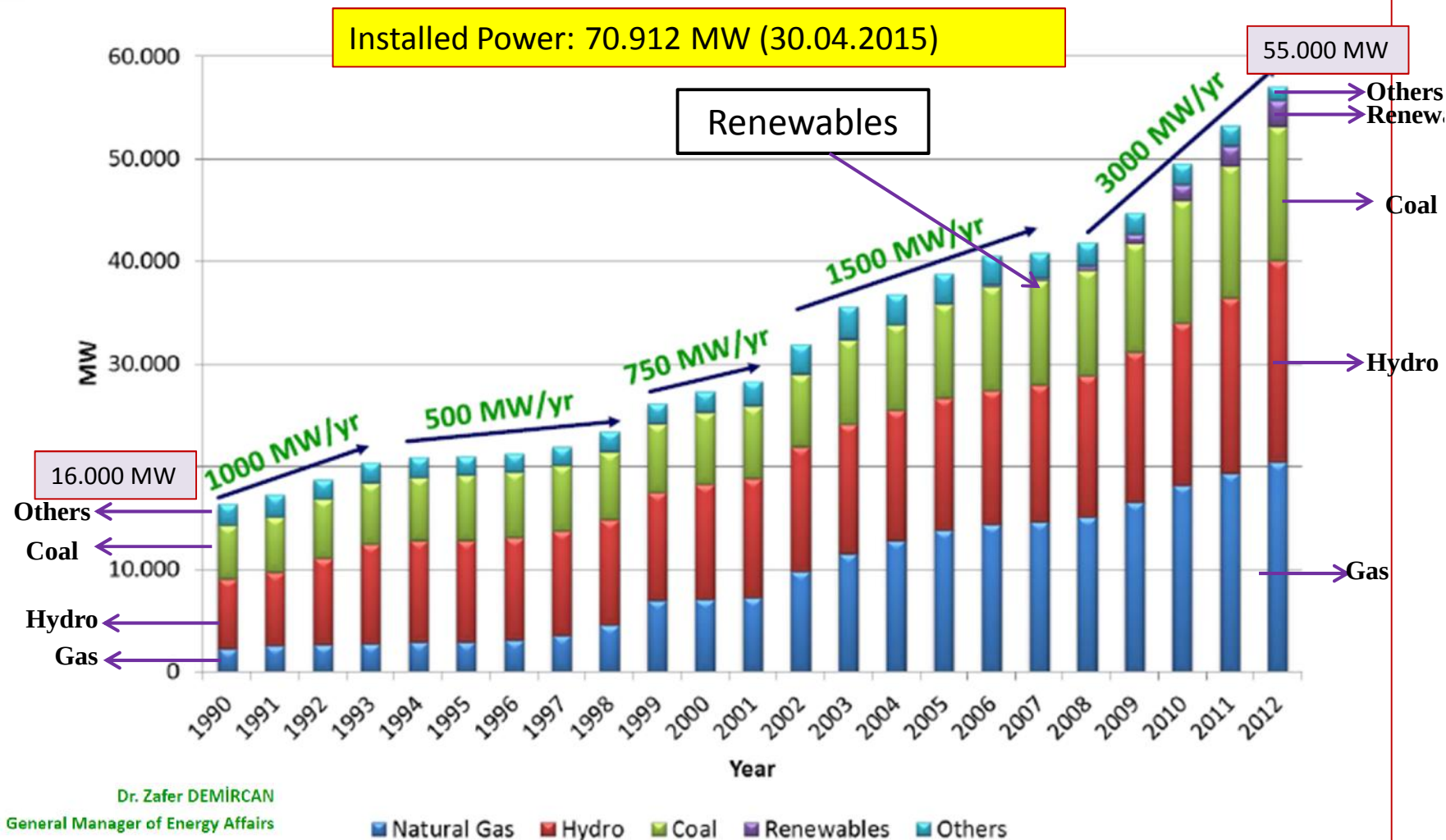
- Turkiye has become one of the fastest growing energy markets in the world in parallel to its economic growth registered over the last ten years.
- Economic expansion, rising per capita income and the rapid pace of urbanization are the main drivers of the energy demand, estimated to increase around 7 percent per annum until 2023.

Source: <http://www.invest.gov.tr/en-US/sectors/Pages/Energy.aspx>

Energy Outlook Of Turkey



Installed Capacity by Resources between 1990-2012



Source: TEIAS

An energy hub

- In addition to having a huge domestic market, Türkiye is strategically located between major energy consumers and suppliers, thus serving as a regional energy hub.
- The existing and planned oil/gas pipelines, the critical Turkish straits and promising finds of hydrocarbon reserves in the country itself give Türkiye increased leverage over energy prices and reinforce its gateway status.

Source: <http://www.invest.gov.tr/en-US/sectors/Pages/Energy.aspx>

Turkiye's ambitious vision for 2023



Envisages grandiose targets for the energy sector in Türkiye. These targets include:

- Lifting up installed power to 120,000 MW
 - **Increasing the share of renewables to 30 percent**
 - **Maximizing** the use of **hydropower** (20,000 MW)
 - **Increasing wind power** installed capacity to 20,000 MW
 - Installing power plants with 600 MW of **geothermal** and 3,000 MW of **solar energy**
 - Extending the length of transmission lines to 60,717 km
 - Reaching a power distribution unit capacity of 158,460 MVA
 - Extending the use of **smart grids**
-
- Raising the natural gas storage capacity to 5 billion m³
 - Establishing an energy stock exchange
 - Commissioning nuclear power plants (two operational nuclear power plants, with a third under construction)
 - Building a coal-fired power plant with a capacity of 18,500 MW

Source: <http://www.invest.gov.tr/en-US/sectors/Pages/Energy.aspx>

Renewables in Turkey

- The renewable forms of energy --**hydro, wind, solar, geothermal and others** -- are abundant in Turkey and encouraging policies backed by favorable feed-in tariffs are expected to increase their share in the national grid in the coming years.
- The Turkish government has made it a priority to increase the share of renewable sources in the country's total installed power to a remarkable **30 percent by 2023**, while taking the energy efficiency concept to realization by enacting laws that set principles for saving energy, both at the individual and corporate levels.

Source: <http://www.invest.gov.tr/en-US/sectors/Pages/Energy.aspx>

Renewable Energy Capacity Targets for 2023

Hydropower Target

Utilizing all economical and possible 36,000 MW hydroelectricity potential by 2023.



Solar Energy Target

Popularizing the use of solar energy in electricity generation and achieving 3,000 MW installed capacity.



Wind Energy Target

Increasing installed capacity of wind energy to 20,000 MW by 2023.



Geothermal Energy Target

Utilizing 600 MW of potential geothermal energy by 2023.



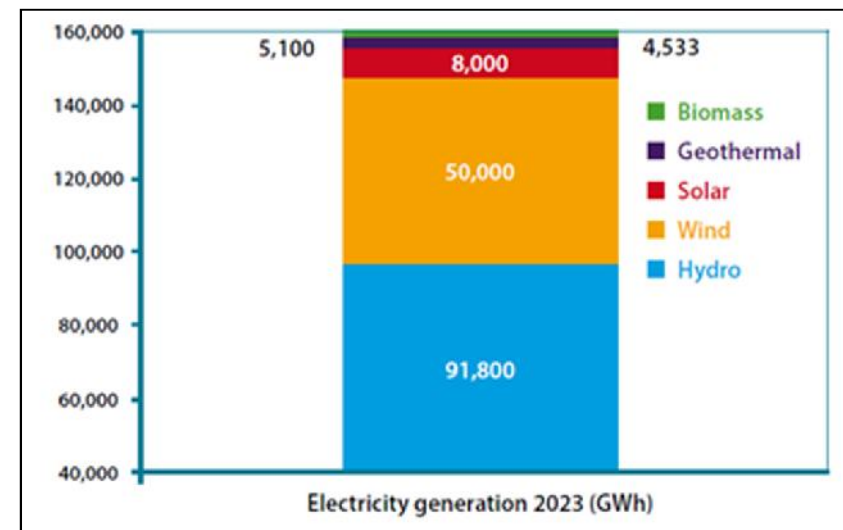
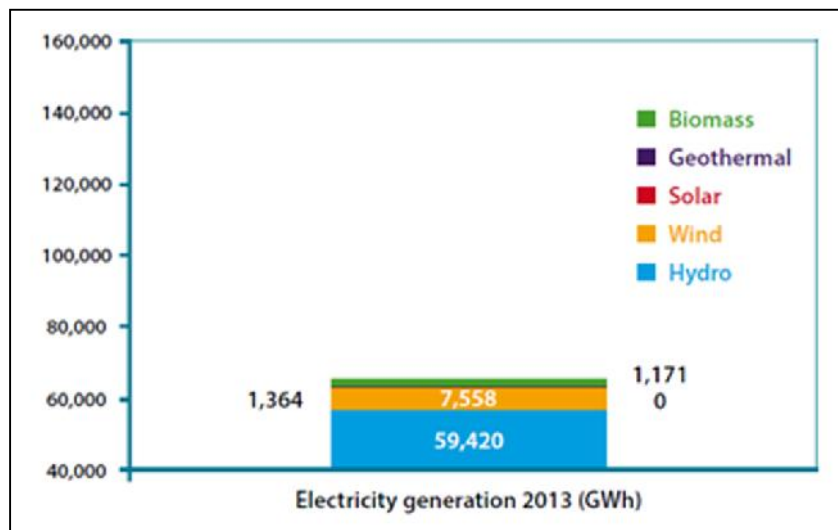
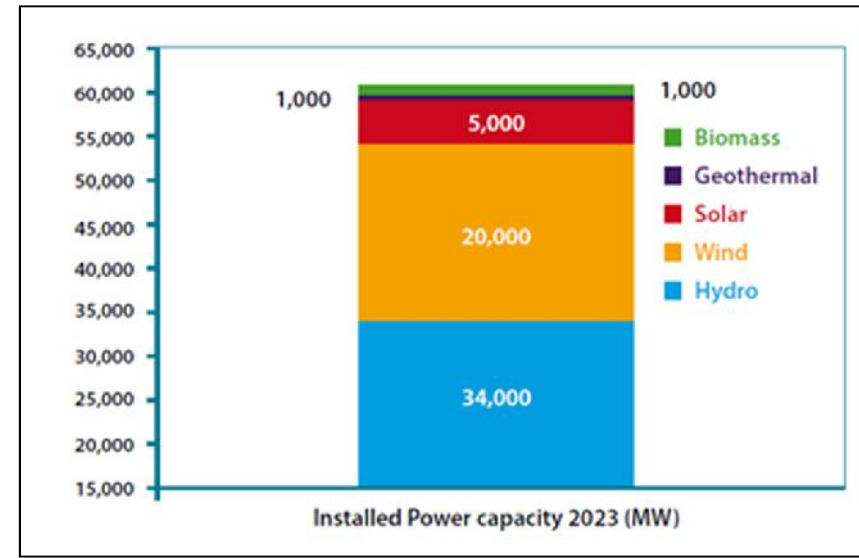
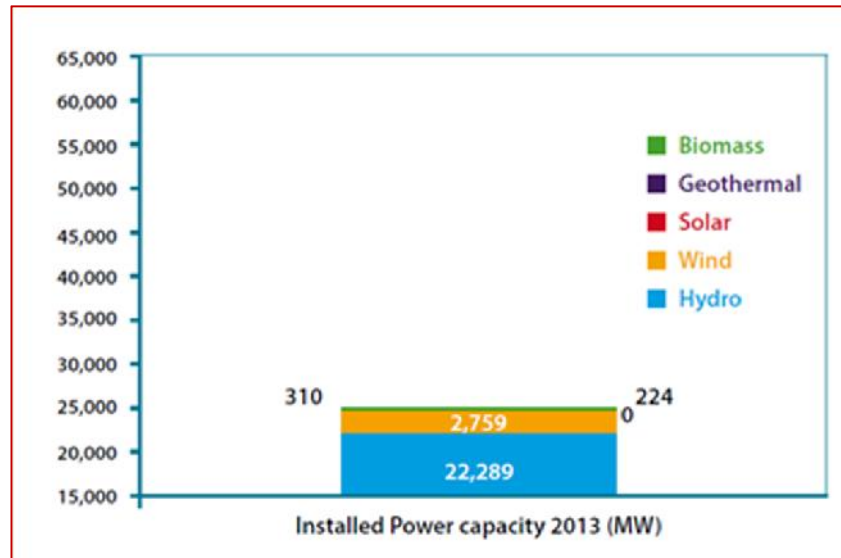
Investment Support and
Promotion Agency of Turkey

Source: TEİAŞ, Strategy Paper, YEGM

12.10.2015

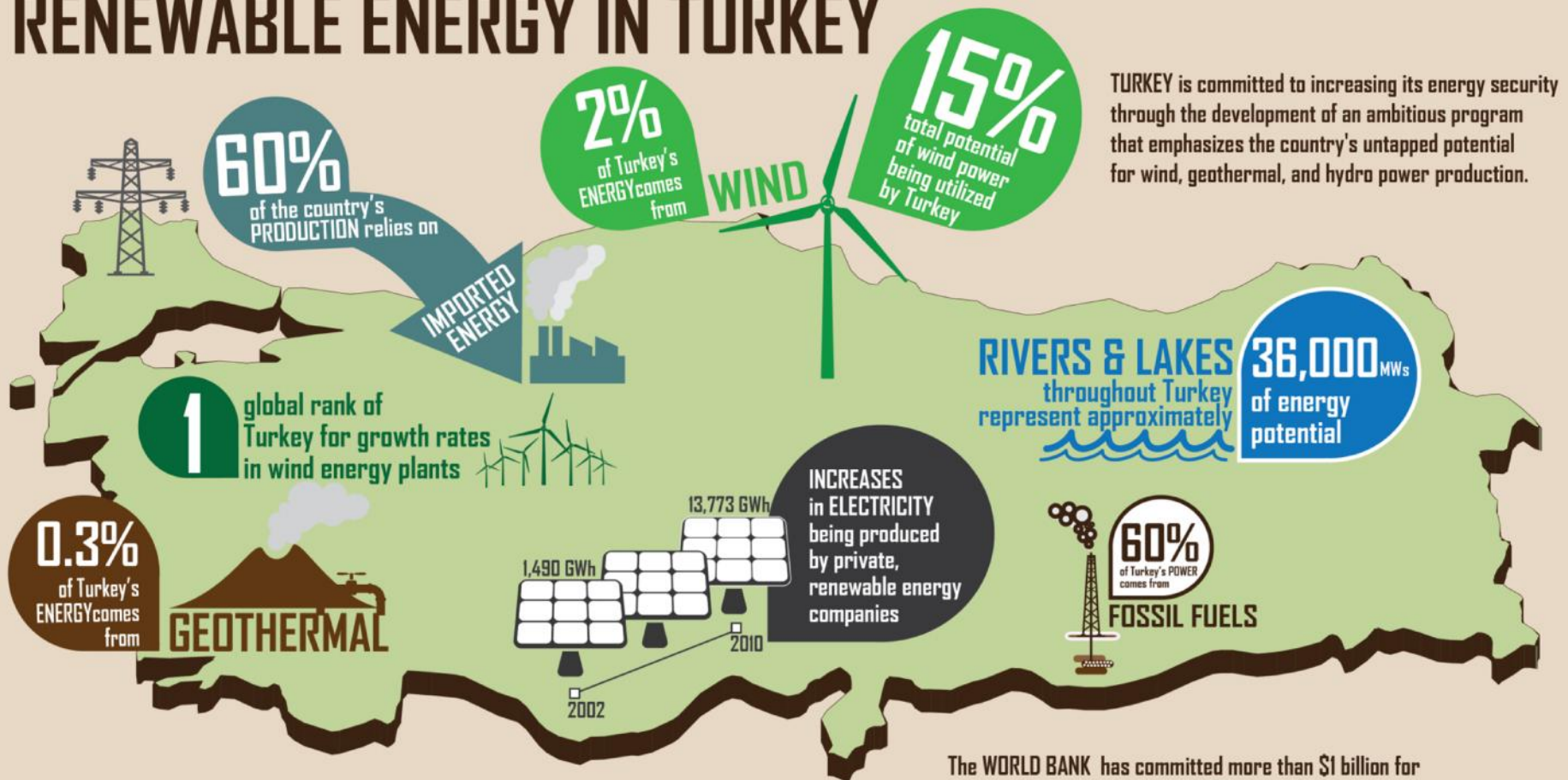
Inconet EaP

Renewable Energy Production Present/Future



[The Turkish 'National Renewable Energy Action Plan'](#) (77-page / 11.3MB PDF)

RENEWABLE ENERGY IN TURKEY



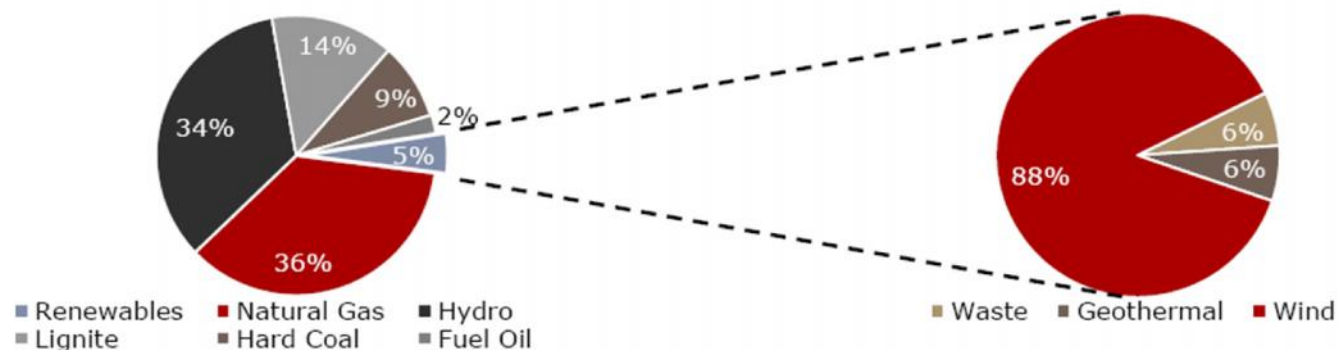
The WORLD BANK has committed more than \$1 billion for renewable energy and energy efficiency projects throughout Turkey

Source: <http://www.worldbank.org/en/news/feature/2013/05/30/wind-water-steam-a-triple-win-for-turkey-energy-sector>

The share of renewables in Türkiye's installed capacity is continuously increasing.

- Turkey's installed capacity in December 2012 was 57,058 MW. Renewables including waste, geothermal and wind accounted for only 5% of the installed capacity, wind energy being the highest with 2,261 MW.
- Regulations designed specifically for wind energy and its growth potential of 48 GW has attracted the interest of domestic and international investors.
- The share of renewables will increase significantly due to the upcoming licensing process for solar power plants and wind project stock.

Figure 12: Turkey's Installed Capacity Including the Share of Renewables, 2012



	Hydro	Natural Gas*	Hard Coal** (Local & Imported)	Lignite	Fuel Oil	Wind	Geothermal	Other Renewables	Total
Installed Capacity (MW)	19,609	20,439	5,058	8,143	1,227	2,261	162	159	57,058
Share	34.37%	35.82%	8.87%	14.27%	2.15%	3.96%	0.28%	0.28%	100%

* Including dual fuel plants

** Including local and imported coal plants & asphaltite plants



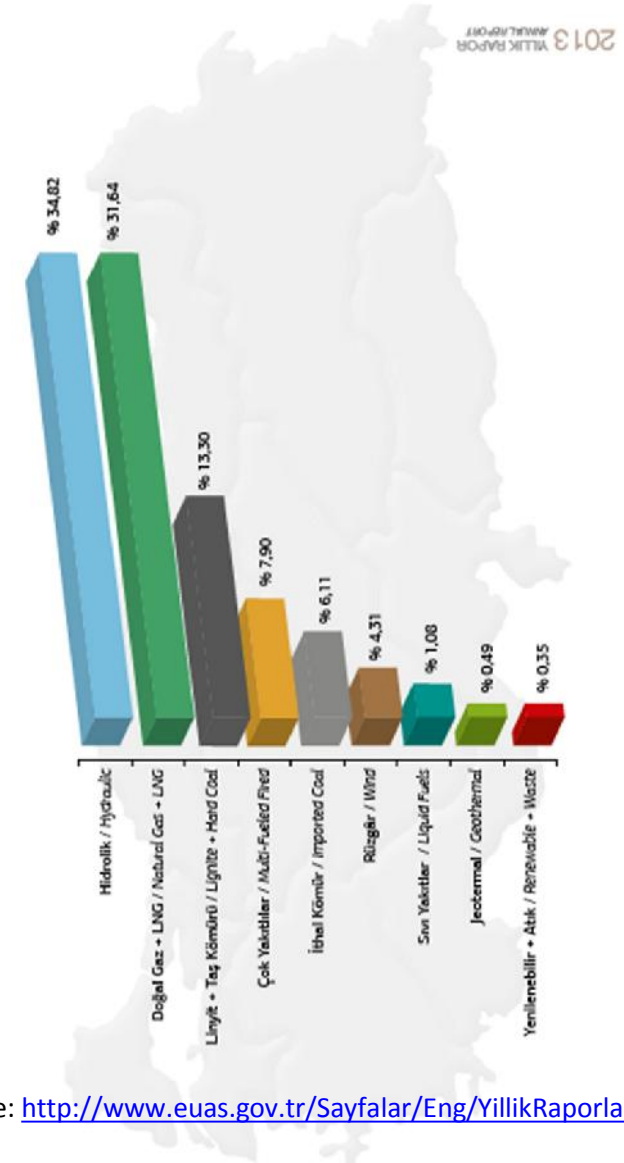
Investment Support and
Promotion Agency of Turkey

Installed Renewable Energy Capacity of Türkiye 2013

TÜRKİYE KURULU GÜCÜNÜN KAYNAKLARA DAĞILIMI

Share of the Resources in Turkey's Installed Capacity

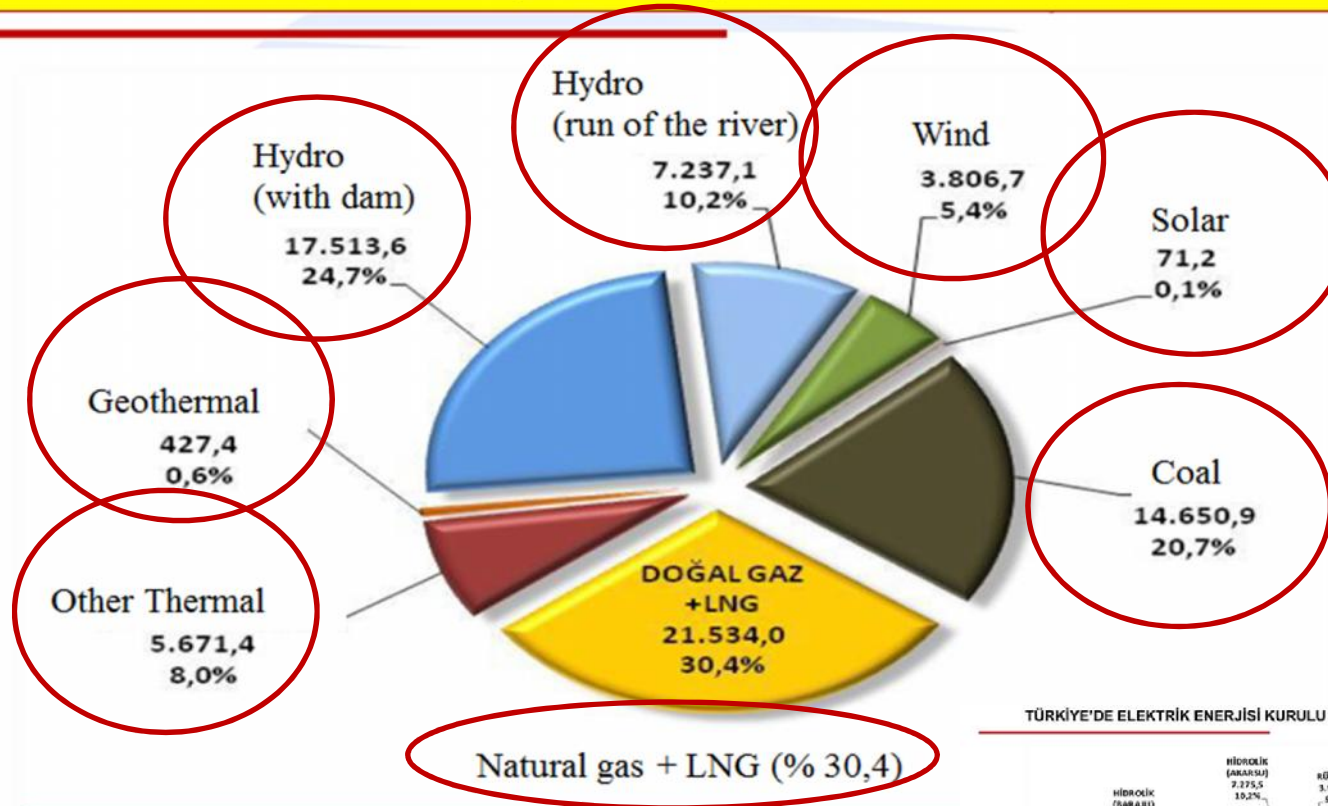
KAYNAKLAR Resources	KURULU GÜÇ / Installed Capacity MW
Hidrolik Hydraulic	22288,9
Doğal Gaz + LNG Natural Gas + LNG	20254,9
Linyit + Taş Kömürü Lignite + Hard Coal	8515,2
Çok Yakıtlılar Multi-Fueled Fired	5048,3
İthal Kömür Imported Coal	3912,6
Rüzgâr Wind	2759,6
Sıvı Yakıtlar (Fuel-Oil + Motorin + Nafta + Asfaltit) Liquid Fuels (Fuel-Oil + Diesel + Naphtha + Asphaltite)	694,1
Jeotermal Geothermal	310,8
Yenilenebilir + Atık Renewable + Waste	224,0
TOPLAM / Total	64.008,4



Source: <http://www.euas.gov.tr/Sayfalar/Eng/YillikRaporlar.aspx>

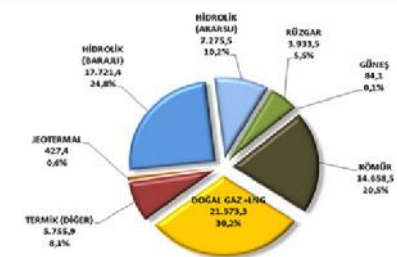
Installed Power Of Turkey

Installed Power: 70.912 MW (30.04.2015)



Installed Power: 70.912 MW (30.04.2015)

TÜRKİYE'DE ELEKTRİK ENERJİSİ KURULU GÜCÜ (31 MAYIS 2015)

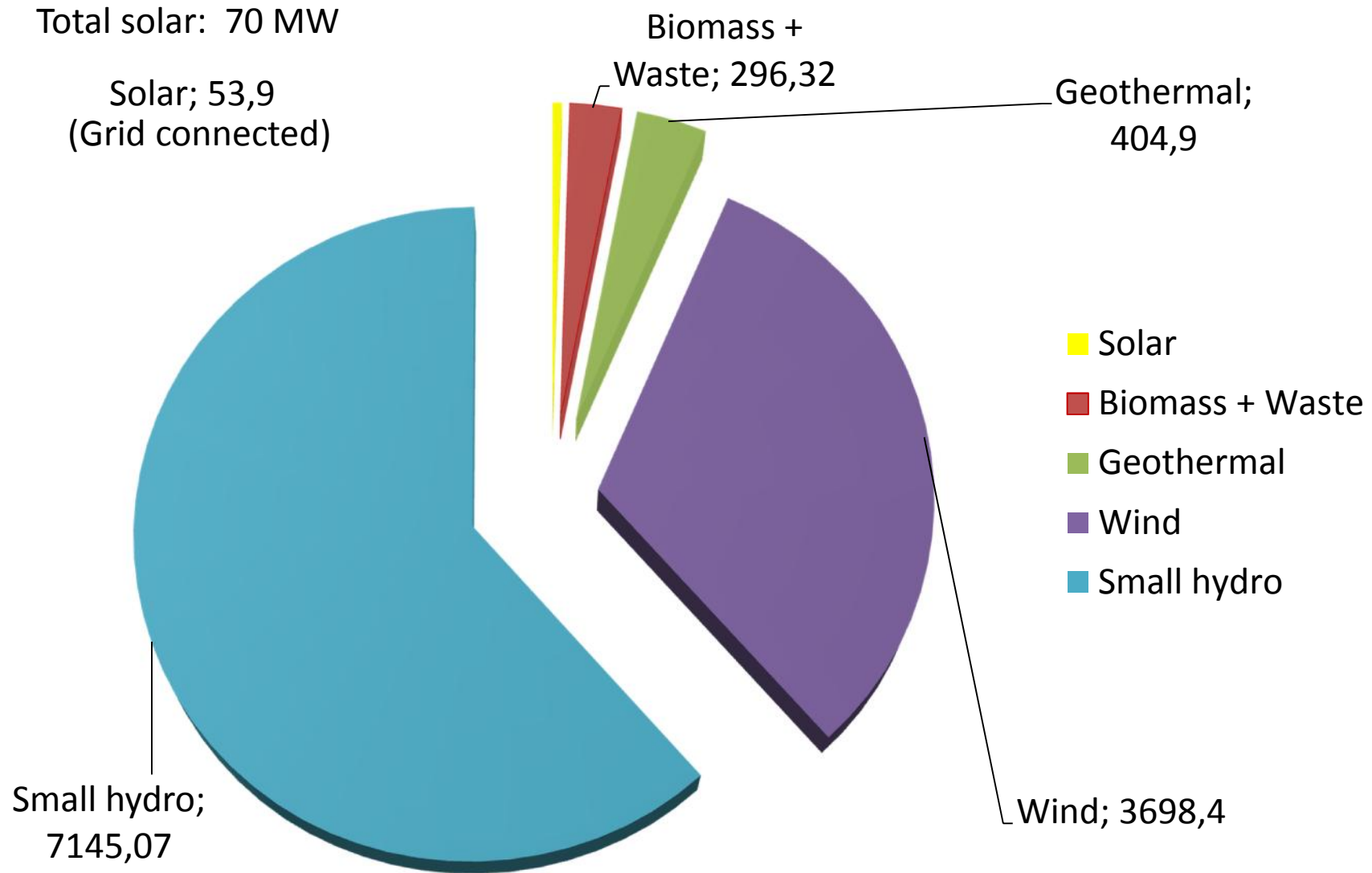


KURULU GÜÇ: 71.429,7 MW

Current status of installed renewable capacity

Total: 11.598,69 MW
(March 2015)

Installed Capacity - MW (March 2015)

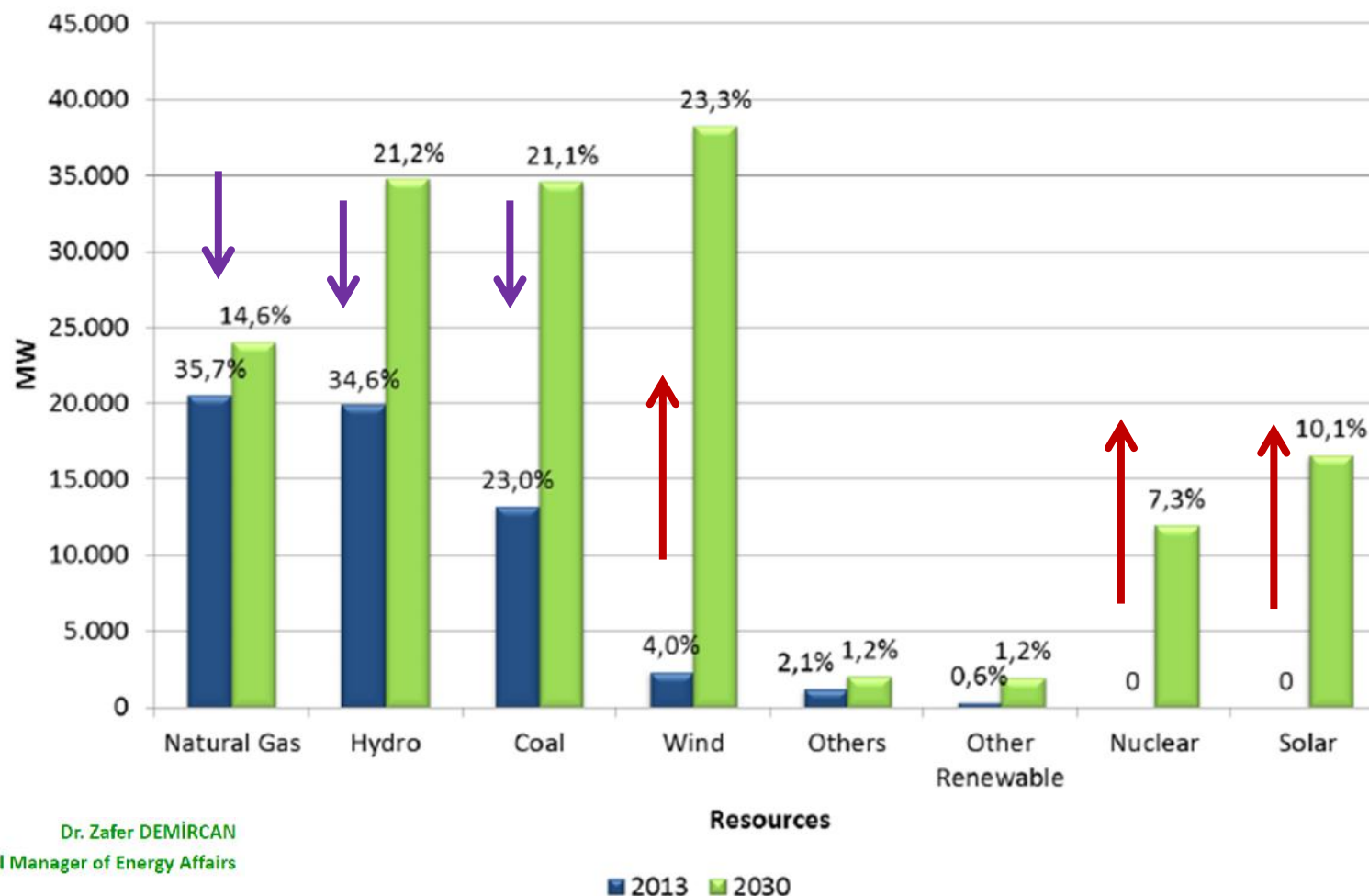


Source: [MENR of Turkey](#)
[TEIAS](#)

Energy Forecast Of Turkey



Installed Capacity by Resources in 2013* and 2030



Source: TEIAS, GDEA

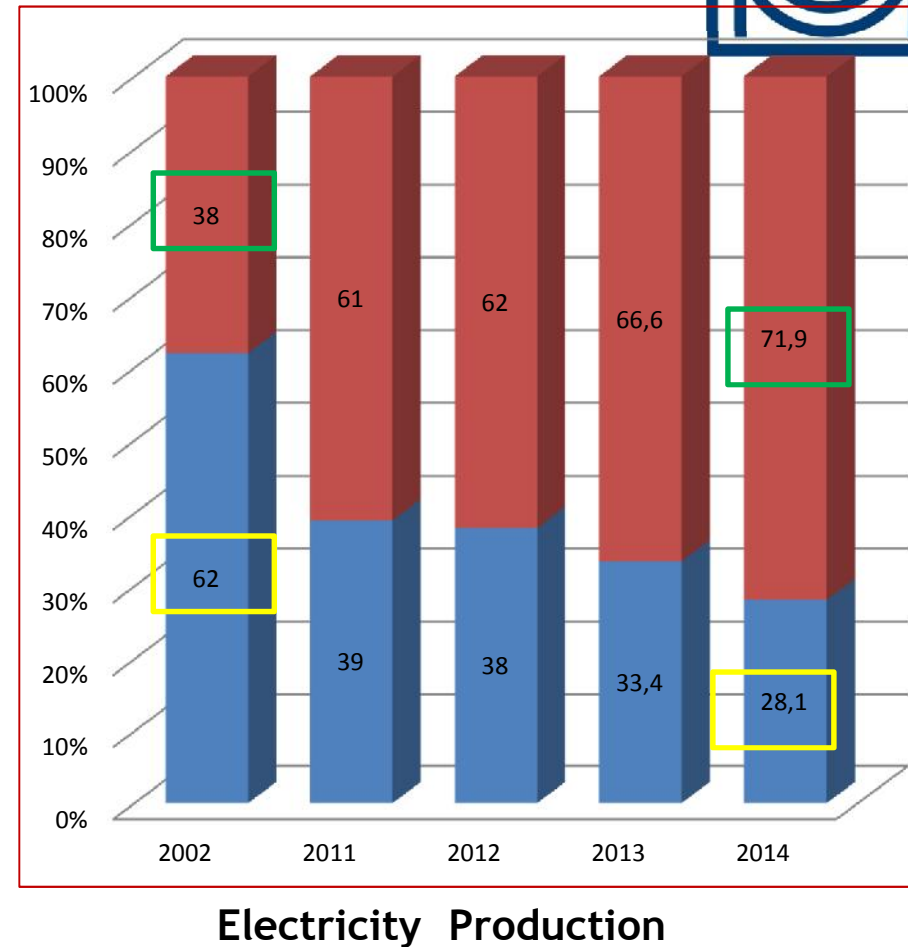
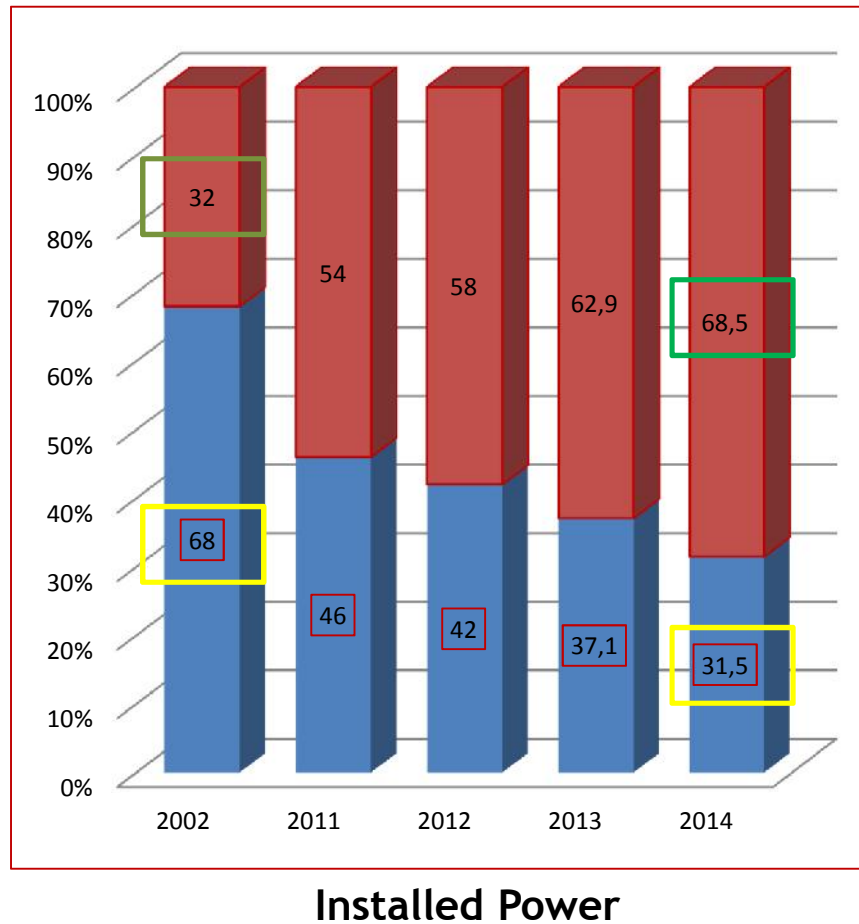
*:As of March 20, 2013

Investment

- As important as the **renewables** are in Türkiye's energy strategy in the coming years, technologies such as **waste processing** and **reducing of greenhouse gasses** are also often cited together with this **new form of power generation** as critically important supplementary practices.
- **The total amount of investments required to meet the energy demand in Türkiye by 2023 is estimated to be around USD 6-7 billion per year.**

Source: <http://www.invest.gov.tr/en-US/sectors/Pages/Energy.aspx>

Public/Private Energy Of Turkey



Public



Private

Kaynak: ETKB

Renewable Energy Credits in Turkey

Type of power plant facility	Feed-in tariff	Maximum local production premium	Maximum possible tariff
Hydroelectric PP →	\$7.3 cents/kWh	\$2.3 cents/kWh	\$9.6 cents/kWh
Wind PP →	\$7.3 cents/kWh	\$3.7 cents/kWh	\$11 cents/kWh
Geothermal PP →	\$10.5 cents/kWh	\$2.7 cents/kWh	\$13.2 cents/kWh
Biomass (including landfill) →	\$13.3 cents/kWh	\$5.6 cents/kWh	\$18.9 cents/kWh
Solar PV PP →	\$13.3 cents/kWh	\$6.7 cents/kWh	\$20 cents/kWh
Concentrating Solar PP →	\$13.3 cents/kWh	\$9.2 cents/kWh	\$22.5 cents/kWh

- In addition, if the mechanical or electro-mechanical equipment of the power plant is produced locally, a premium shall be added to the feed-in tariffs during the first five years of operation.

The maximum installed capacity for a renewable energy plant to operate without a license has been raised from 500 kW to 1 MW, with the ease of increasing up to 5 times (5 MW) by a decree of the Council of Ministers without a change in the Law. Furthermore, with the new Law, there is no limit for renewable energy facilities that serve for self-consumption without feeding into the grid.

Turkey's Renewable Energy Sector from a Global Perspective, F. Sabuncu, M. Colakoglu,
www.pwc.com.tr

Research challenges needs to be addressed

- **TUBITAK MRC and other R&D organisations are working on;**
- Mitigation of line losses,
- Understanding the regional resource for different renewables,
- Managing system stability over long distances,
- Understanding and mitigating network constraints,
- Managing conventional generation plant (fossil and nuclear) to work with renewable generation,
- The move from centralized to decentralized (distributed) generation,
- Developing improved demand side management systems,
- Development of dispatch strategies that are based on renewable resource forecast and storage options,
- Identification of grid extension requirements to achieve a penetration of renewable electricity

*

SOURCE: RESEARCH PRIORITIES FOR RENEWABLE ENERGY TECHNOLOGY BY 2020 AND BEYOND <http://www.energy.eu/publications/a06.pdf>

Applied technological research activities of TUBITAK MRC Energy Institute



TUBITAK MRC ENERGY INSTITUTE 2015

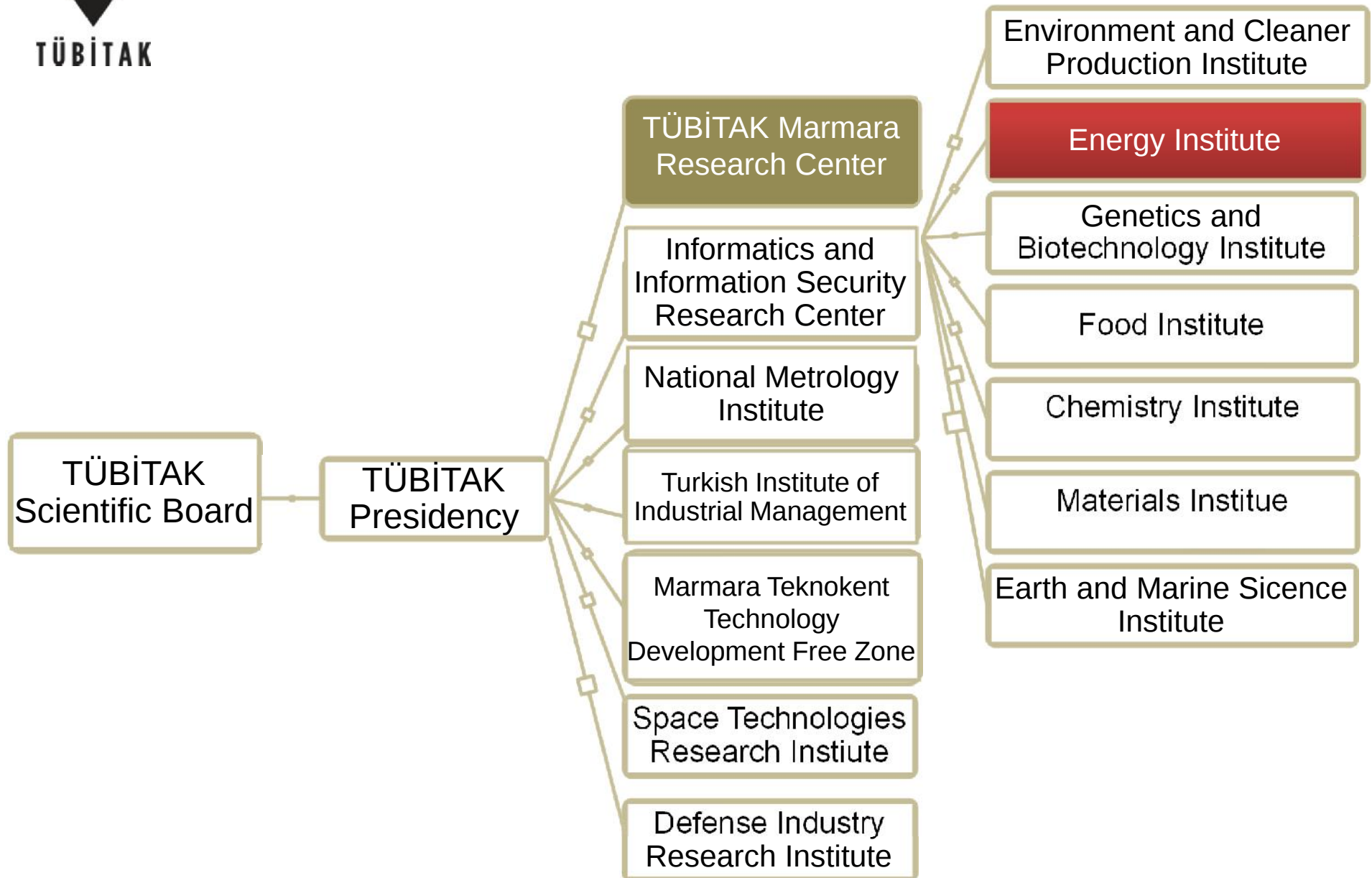


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22

Organizational Chart



Staff Profile

Staff

Energy Institute Staff (Gebze)

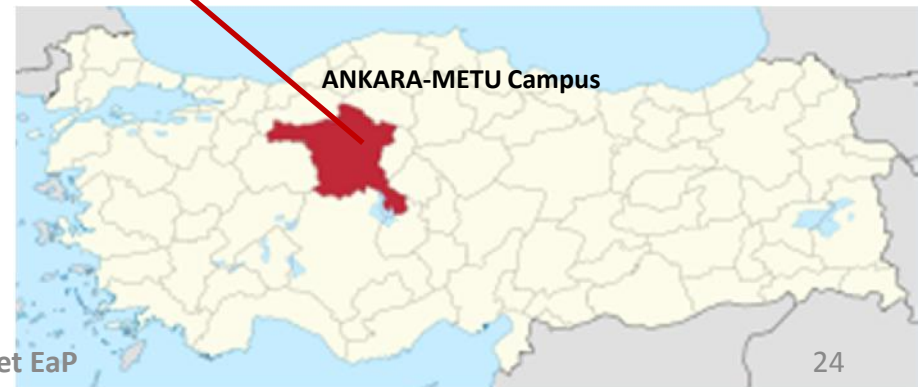
178

Energy Institute Staff (Ankara)

81

Total 256

TÜBİTAK MAM Eergy Institute



Profile

Management

3

Researcher

189

- PhD:44
- MSc:77
- BSc:68

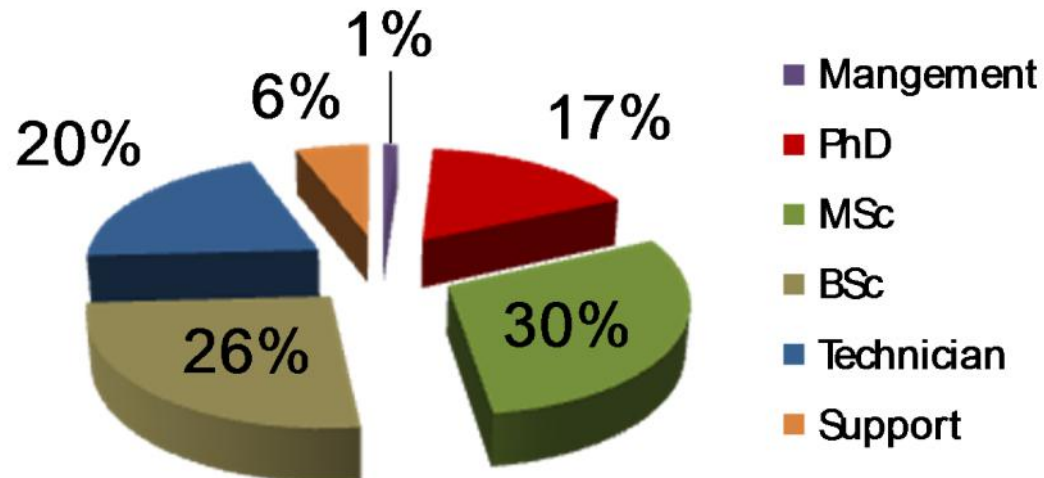
Technician

52

Support

15

Total 259



Bussiness Model



**Project Based Applied
R&D Activities**



Consultancy



**Tests and Analysis
(Industrial Services)**

Laboratories

GEBZE

- Vehicle Laboratory/ Hybrid and Electric Vehicles Excellence Center
- Battery Technologies Laboratory
- Power Electronics Laboratory
- Gas Technologies Laboratory
- Solid and Liquid Fuel Analysis Laboratory
- Combustion and Gasification Technologies Laboratory
- Fuel Cell Technologies Laboratory

ANKARA

- Low Voltage Laboratory
- High Voltage Laboratory
- Integration Laboratory



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27

Research Teams

GEBZE LOCATION



Thermal Power
Plant
Technologies



Combustion
and
Gasification
Technologies



Gas
Technologies



Fuel Cell
Technologies



Fuel
technologies

Research Teams

GEBZE LOCATION



Vehicle
Technologies



Battery
Technologies



Power
Electronics
Technologies

Research Teams

ANKARA LOCATION



Inverter
Technologies

Power
Systems
Analysis
and
Planing

Power
Systems
Information
Technologies

Automation
Technologies

Renewable energy activities

Power, gas and liquid fuel production from biomass and waste:

- Fluidized Bed Gasification Technologies
- Fluidized Bed Combustion Technologies
- Gas Cleaning Technologies
- Combined Heat and Power System
- CO₂ Capturing
- Catalyst Development, Characterization and Tests



- Waste heat utilization and district heating systems
- Heat storage systems



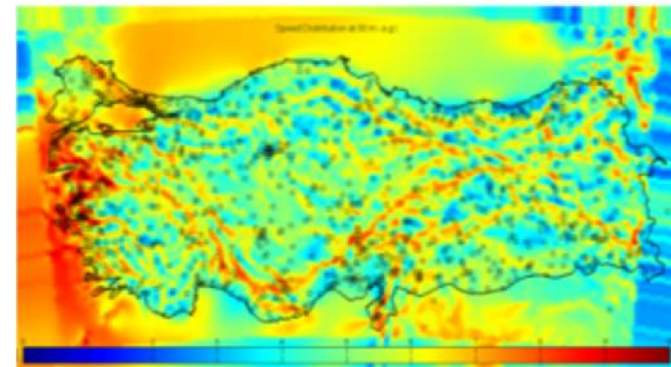
- Hybrid and Electric Vehicles
 - Electrical traction systems
 - Vehicle Control Unit
 - Vehicle dynamics and modeling



- Development and application of converter technologies for grid-connection of renewable energy sources



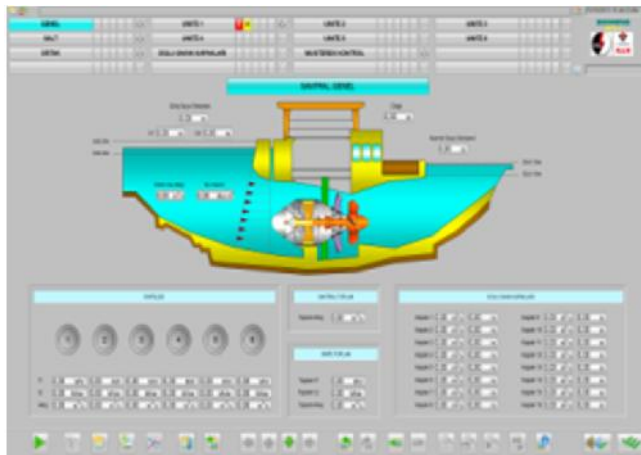
- Integration of Renewable Energy Sources into Electrical Systems



- Development and application of wide area monitoring and control systems.
- Development and application of monitoring and forecast system for wind power
- Analysis and planning of wind and solar farms.



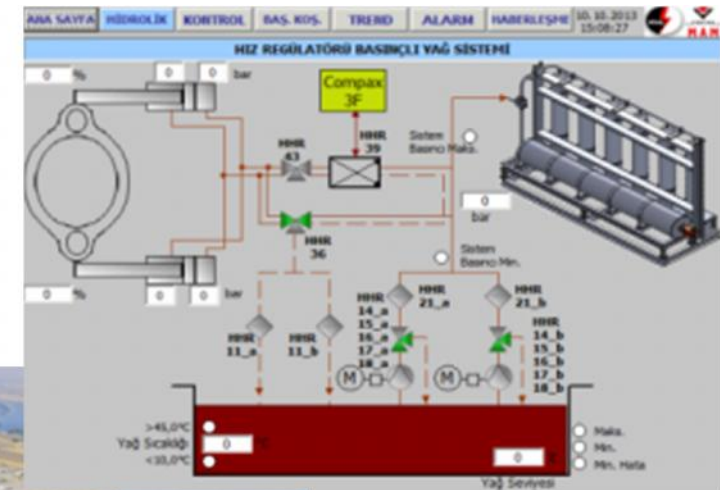
- Hydroelectric Power Plant Control Technologies
- Protection and Synchronization Systems
- Speed Regulator
- Hydro Turbine Design
- Smart Grid Design
- Inverter and Protection Systems for Micro-grids



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35

Renewable energy related projects

Liquid Fuel Production from **Biomass** and Coal Blends

- to produce more economic, efficient and clean liquid fuels from coal and biomass,
- to enhance the utilization of the widespread national resources
- to develop technologies to be used in industry,
- to demonstrate the outcomes in pilot scale.

TÜBİTAK 1007 project



T.C.
ENERJİ VE
TABİİ KAYNAKLAR
BAKANLIĞI



Duration: 5,5 Years / 2009-2014



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- **Innovative Aspects:** Fuel feeding, gasification, gas cleaning, gas conditioning and separation, liquid fuel production systems, heat and electricity generation systems will be integrated.
- **Planned Systems:** 200 kg/h feed capacity.

MILHES - Hydroelectric Power Plant Rehabilitation

- Upgrading Control, SCADA ve Communication systems modernization
- Increasing power plant efficiency



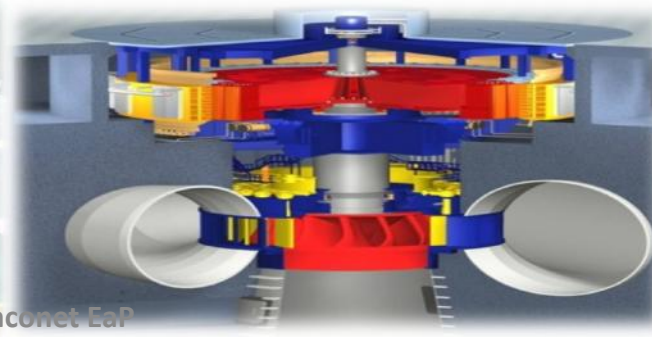
Duration: 4 Years / 2013-2017



DAMs

**Seyhan-1 HES
Karkamış HES
Kadıncık 1-2 HES
Batman HES**

Turbine, generator, scada

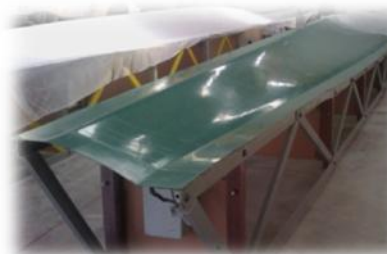
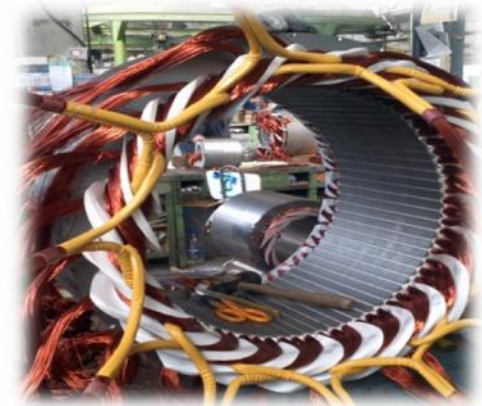
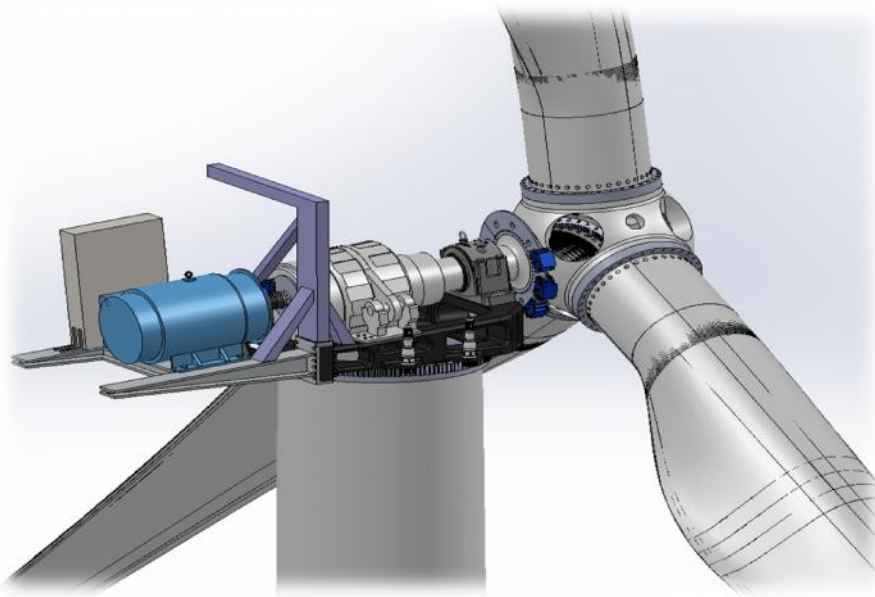


MILRES -Development of National Wind Energy Systems and Prototype Turbine Production/ Generator Design

**Generator design for the
national Wind Turbine (500 kW
+ 2,5 MW)**

TÜBİTAK 1007 project

1.Phase (500 kW)
Duration: 2,5 Years/ 2011-2014



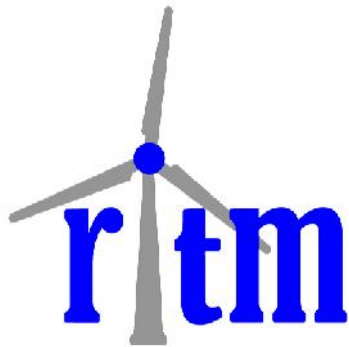
Generator and blades

Wind Monitoring and Forecast Project

- Installation and nationwide spreading of the wind power monitoring and forecast in order to achieve wide scale integration of the wind power generation in Türkiye
- Contribute TEİAŞ for the infrastructure of a possible wind bureau
- Increase the efficient use of renewable energy



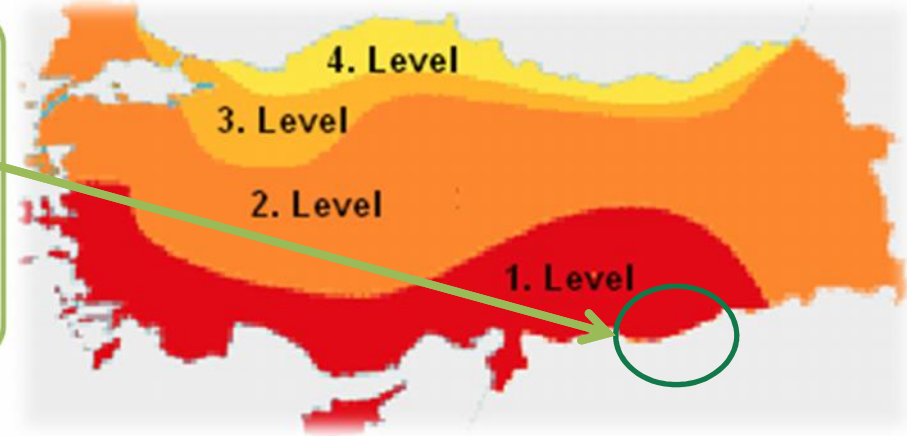
Duration: 5 Years / 2010-2015



MILGES – Development of solar energy technologies

- Project site: SANLIURFA
- Panel production, inverter and SCADA development

Duration: 5 Years / 2014 - 2017



E1000

➤ E1000 Electrical Locomotive Development



AC Traction converter and vehicle central control system design and prototype production

TÜBİTAK 1007 project

Duration: 3,5 Years/ 2011-2014



BOREN (National Boron Institute) Projects

- Boron Based Fuel Cell Development for Unmanned Vehicles
- Boron Based Fuel Cell Range Extender for Electric Vehicles



Duration: 2 Years / 2013-2015



KACST Projects

King Abdulaziz City for Science and Technology (KACST) Projects



- Tecnology Collaboration for Power Quality Monitoring (2013-2014)
- Smart Grid Controller For PV Network Project
- Development of SVC systems for KACST Institute in Saudi Arabia as a technology transfer project (2011-2013)
- Development of micro-inverter for photovoltaic applicaiton (2011-2013)



Duration: 4 Years/ 2010-2014



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44



- **BRISK (7th FP)** European Research Infrastructure for Thermochemical **Biomass Conversion** - <http://www.briskeu.com/>
- **MCFC-CONTEX (6th FP)** Effects of CONtaminants in biogenous fuels on MCFC catalyst and stack component degradation and lifetime and EXtraction strategies - <http://mcfc-contex.enea.it/>
- **ETRERA 2020 (7th FP)** – Empowering Trans-Mediterranean **Renewable Energy** Research Alliance for Europe 2020 Challenges - <http://www.etrera2020.eu/>
- **ELECTRA (7th FP)** - European Liaison on Electricity Committed Towards **long-term Research Activities for Smart Grids** - <http://www.electrairp.eu/>
- **IRPWIND (EERA Project)** –Integrated Research Programme on **Wind Energy** - <http://www.irpwind.eu/>

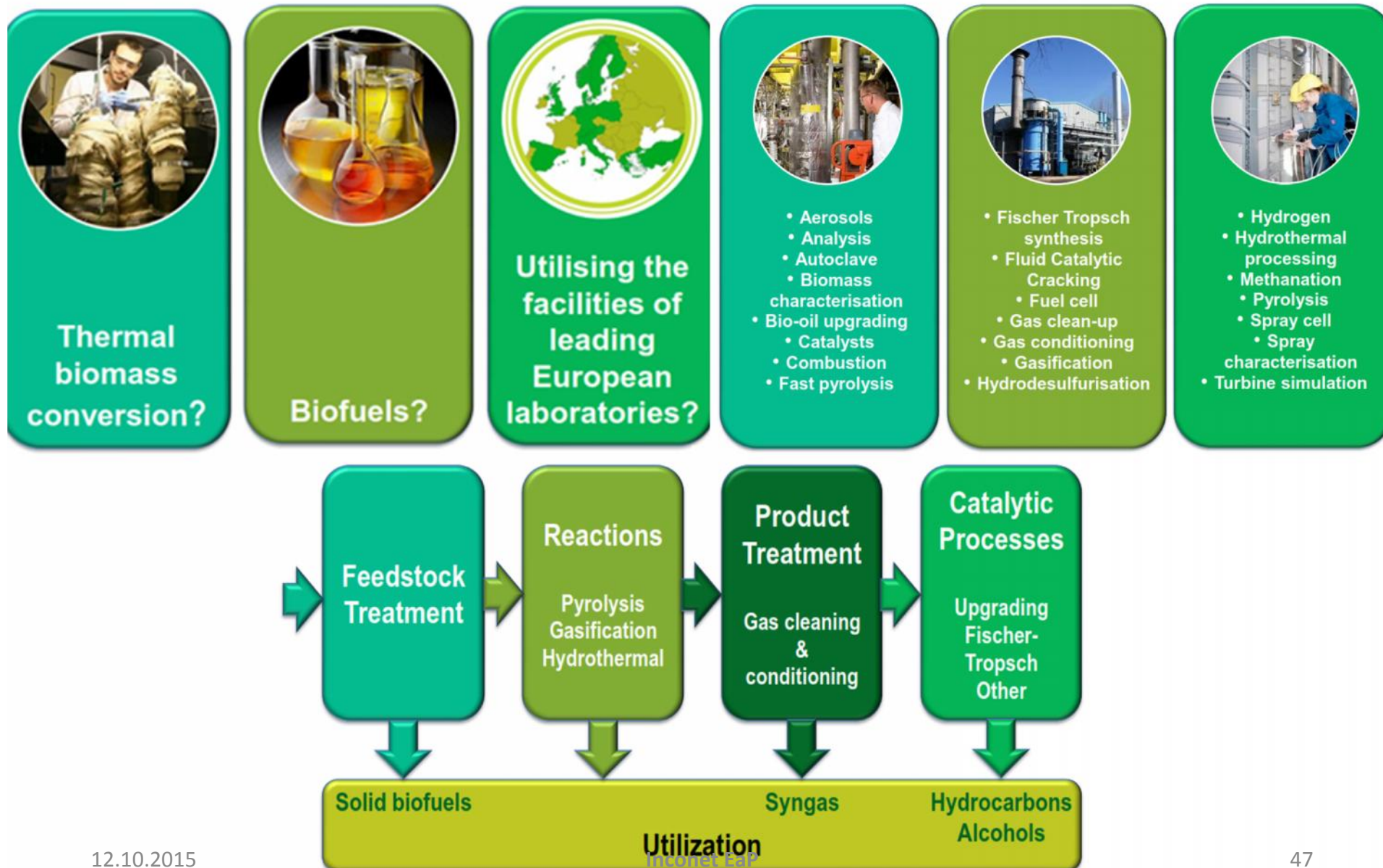


Completed projects

- **TYGRE (6th FP)** High Added Value Materials From Waste Tyre Gasification Residues
- **AB-E2PHEST2US (7th FP)** -Enhanced Energy Production of Heat And Electricity By a Combined **Solar** Thermionic-Thermoelectric Unit System
- **MC-WAP (6th FP)** Molten-Carbonate Fuel Cells For Water Borne Applications
- **EU-DEEP (6th FP)** The Birth of A European Distributed Energy Partnership That Will Help The Large-Scale Implementation of **Distributed Energy Resources** in Europe
- **NATURAL-HY (6th FP)** Preparing for the **hydrogen economy** by using the existing natural gas system as a catalyst.
- **TERMISOL (6th FP)** New Low Emissivity and Long-lasting Paints for **Cost Effective Solar Collectors**
- **HYPROSTORE (6th FP)** Improving of the S&T Research Capacity of TUBITAK MRC IE in the Fields of **Hydrogen Technologies**
- **BIGPOWER (6th FP)** Improving of the S&T Research Capacity of TUBITAK MRC IE in the Fields of Integrated **Biomass Gasification** with Power Technologies
- **NETBIOCOF (6th FP)** Integrated **European Network For Biomass Co-Firing**
- **CASES (6th FP)** Cost Assessment **Sustainable Energy Systems**
- **MOCAMI (5th FP)** Development and demonstration of a small-sized hybrid system with the combination of the MCFC technology and a microturbine
- **IRMATECH (5th FP)** Integrated Research on Materials, **Clean and efficient energy Technologies** and processes to enhance MCFC in a sustainable development
- **BIOCOGEN (5th FP)** **Biomass** Cogeneration Network



The European Research Infrastructure for Thermochemical Biomass Conversion



Biomass characterization and gasification at TUBITAK



RENETECH (İsveç) – TUBİTAK MAM EE JRA



Nichanut Prasopsaipornkul of Renetech AB in Sweden undertakes work on maximising the potential of cocoa pod husk residue at TUBITAK Marmara Research Centre in Turkey.



Cocoa Pod Husk: which are the residue from cocoa production and currently an underused resource in Côte d'Ivoire



10 kWth Biomass Gasification

Torrefaction



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Tar Samples



Torrefied Samples



TyGRe—High added value materials from waste tyre gasification residues

FP7-ENV-2008-1 Collaborative Project
(01 September 2009 – 01 March 2013)



THE REASONS BEHIND THE PROJECT IDEA

Current European Union Regulations promote the recycling of wastes. In this direction, TYGRE Project aims at production of silisium carbide with the reaction of silisium oxide and carbon residue left after gasification.



Hard mineral well suited to working on hard metals like cobalt, titanium and high nickel alloys



Membranes and particulate filters

SiC MARKET per SECTOR

REFRATORIES & FORGING

690,000 MT 60%

ABRASIVE & CERAMICS

320,000 MT 28%

ELECTRO-PRODUCTS

140,000 MT 12%

Source : ASIAN METAL LTD



*Gas Engine,
Special Construction for H₂
Rich Gases*

Gas Conditioning Unit



Participating Organizations & International Cooperation Means



Bioenergy

Have a look at the participants/associates

Participants/Associates: [Aalborg University \(DK\)](#), [BERA \(BE\)](#), [CEA \(FR\)](#), [CENER \(ES\)](#), [CIEMAT \(ES\)](#), [CNR \(IT\)](#), [CNRS \(FR\)](#), [CUT \(PL\)](#), [CUTEC \(DE\)](#), [ECN \(NL\)](#), [ENEA \(IT\)](#), [FZJ-HGF \(DE\)](#), [IEn \(PL\)](#), [IFFMPAS \(PL\)](#), [IFK Stuttgart \(DE\)](#), [IMDEA \(ES\)](#), [INRA \(FR\)](#), [KIT \(DE\)](#), [LNEG \(PT\)](#), [Lund University \(SE\)](#), [METLA \(FI\)](#), [PSI \(CH\)](#), [Technical University of Denmark-DTU \(DK\)](#), [SINTEF \(NO\)](#), [SP \(SE\)](#), [TECNALIA \(ES\)](#), [TUBITAK Marmara Research Centre \(TR\)](#), [UKERC \(UK\)](#), [University of Padova \(IT\)](#), [University of Perugia \(IT\)](#), [UNIZAR \(ES\)](#), [VTT \(FI\)](#), [Wageningen University \(NL\)](#)

Wind Energy

Have a look at the participants/associates

PARTICIPANTS/ASSOCIATES

[BERA \(BE\)](#), [CENER\(ES\)](#), [CIEMAT \(ES\)](#), [CNR \(IT\)](#), [CRES\(GR\)](#), [CTC \(ES\)](#), [DHI \(DK\)](#), [DLR \(DE\)](#), [DTU Wind Energy \(DK\)](#), [ECN \(NL\)](#), [ENEA \(IT\)](#), [FhG IWES \(DE\)](#), [Forwind/Univ. of Oldenburg \(DE\)](#), [Forwind/Univ. of Bremen \(DE\)](#), [Forwind/Univ. of Hannover \(DE\)](#), [IEn \(PL\)](#), [IFE \(NO\)](#), [IREC \(ES\)](#), [LNEG/INETI \(PT\)](#), [NAREC \(UK\)](#), [NTNU \(NO\)](#), [MARINTEK \(NO\)](#), [SINTEF \(NO\)](#), [SINTEF MC \(NO\)](#), [Technical University of Delft \(NL\)](#), [Tubitak \(TR\)](#), [University College of Dublin \(IR\)](#), [Univ. of Aalborg \(DK\)](#), [University of Porto \(PT\)](#), [Univ. of Strathclyde \(UK\)](#), [VTT \(FIN\)](#), [WMC \(NL\)](#); [CIRCE – Centro de Investigación de Recursos y Consumos Energéticos \(ES\)](#), [CMR \(NO\)](#), [IC3 \(ES\)](#), [IK4 \(ES\)](#), [TECNALIA \(ES\)](#), [University of Athens \(GR\)](#), [University of Bergen \(No\)](#), [Univ. of Stuttgart \(DE\)](#), [Politecnico di Milano \(IT\)](#), [Middle East Technical University – Center for Wind Energy \(TR\)](#)

PARTICIPANT/ASSOCIATES IN PROGRESS

[RWTH University Aachen](#), [TUM München](#)

Smart Grids

Have a look at the participants/associates

SUB-PROGRAM COORDINATORS:

[TNO \(NL\)](#), [Technical University of Denmark – DTU \(DK\)](#), [VITO \(BE\)](#), [VTT \(FI\)](#), [SINTEF \(NO\)](#)

PARTICIPANTS/ASSOCIATES

19 full participants 8 associated participants

STEERING COMMITTEE MEMBERS

[RSE \(IT\)](#), [ENEA \(IT\)](#), [AIT \(AT\)](#), [VITO \(BE\)](#), [LABORELEC \(BE\)](#), [Technical University of Denmark – DTU \(DK\)](#), [VTT \(FI\)](#), [CEA \(FR\)](#), [IWES \(DE\)](#), [CRES \(GR\)](#), [IPE-IEN \(LV\)](#), [SINTEF \(NO\)](#), [IEN \(PL\)](#), [TECNALIA \(ES\)](#), [EC JRC \(NL/BE\)](#), [TNO \(NL\)](#), [INESC Porto \(PT\)](#), [TUBITAK \(TR\)](#), [Univ. of Strathclyde \(UK\)](#)

Project Opportunities

- Future calls for **HORIZON 2020**
- **Bilateral programs** between TUBITAK & EU – non-EU organisations
- The **European Energy Research Alliance (EERA)** projects (EERA Bioenergy , Wind, Smart Grid etc.)

Thank you for your attention

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