

***Least Cost Optimisation
Modelling of the
2020 Energy and Environmental
targets in EU27***

Dr George Giannakidis
Centre for Renewable Energy Sources and
Saving, Greece

November 15th 2010, University College Cork, Ireland



***Pan European TIMES Model
General Description***

The Pan European Times (PET) Model is a multi-regional technical economic optimisation model built with TIMES.

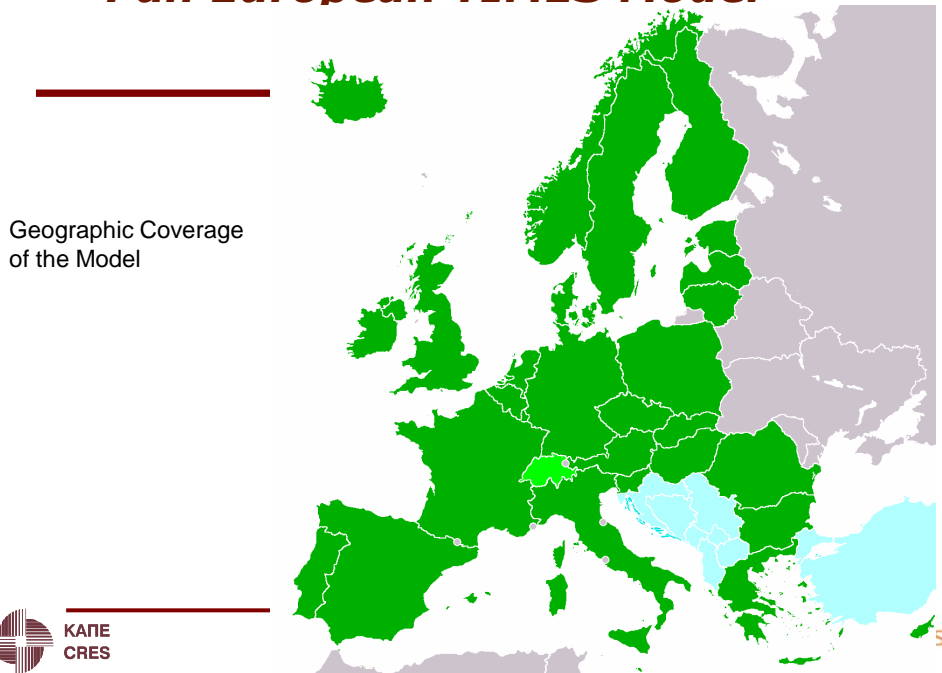
The PET has been originally developed in the

- NEEDS project (FP6 Integrated Project on New Energy Externalities – Developments for Sustainability www.needs-project.org)

In the framework of RES2020 it has been extended to deal with renewables in more detail and to include renewable policy options.



Pan European TIMES Model

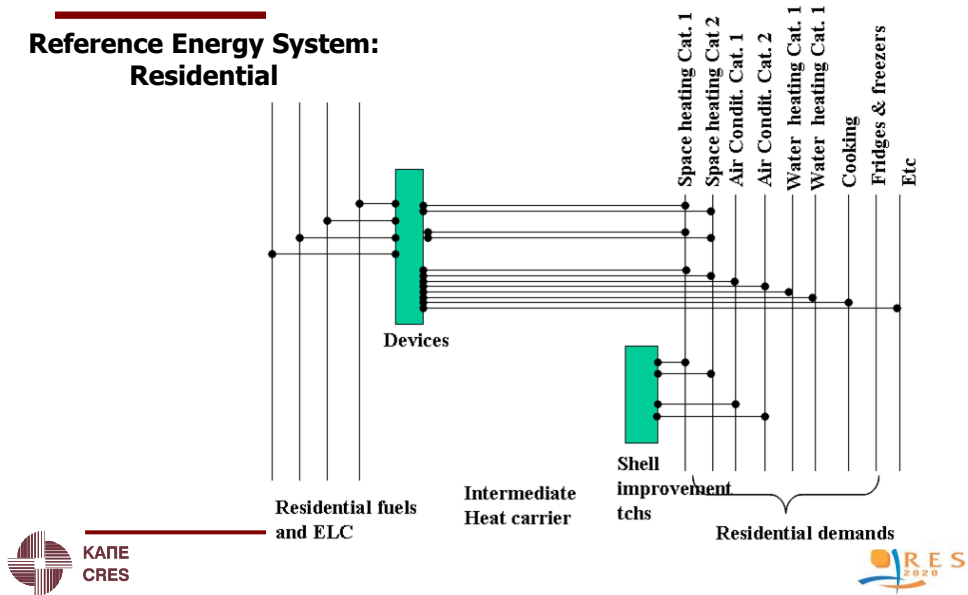


Pan European TIMES Model Highlights

- 5 demand sectors (AGR, RSD, COM, IND and TRA)
- Supply sector description (fuel mining, primary and secondary production, import and export)
- Power generation sector description (autoproducer and CHP included)
- Electricity Multi-grid model (high, medium and low voltage grid)
- Electricity/Biomass and Biofuels trade feature between the European countries
- Country specific differences for characterisation of the conversion and end-use technologies
- Country specific seasonal availability factors for wind
- Renewable potential (onshore wind, offshore wind, geothermal, biomass, biogas, hydro (small, large), pump storage)
- Land use constraints for biomass production
- CO2 Emissions

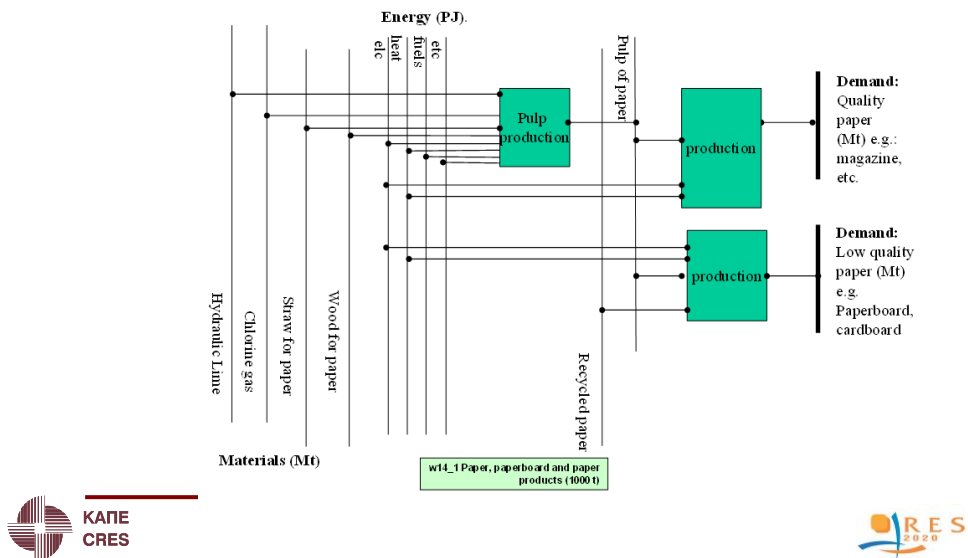
Pan European TIMES Model (Cont.)

Reference Energy System: Residential



Pan European TIMES Model (Cont.)

Reference Energy System: Pulp and Paper



Pan European TIMES Model (Cont.)

Endogenous trade of Electricity

Endogenous electricity import/export between the EU countries.

Existing Lines with Capacities are in the model.

Extension of lines possible (with associated cost).

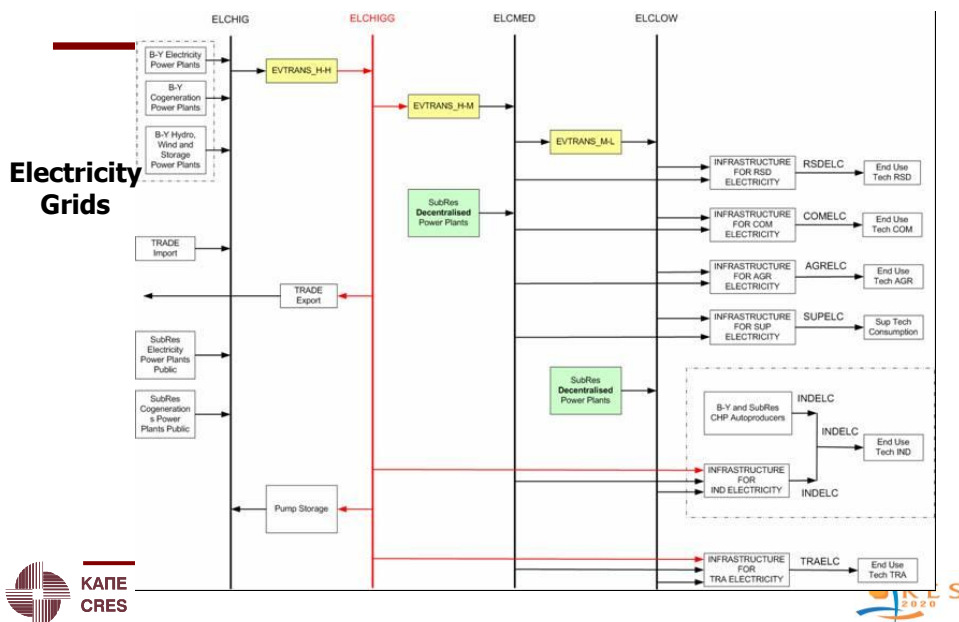
Exogenous import/export of Electricity from ROW

Added the exogenous import/export with the ROW for:

- Bulgaria
- Finland
- Hungary
- Latvia
- Poland
- Spain
- Greece
- Lithuania
- Slovenia
- Slovakia



Pan European TIMES Model (Cont.)



Pan European TIMES Model

Biofuels and Biomass

- The basic enhancements are:
 - Differentiation of potentials of energy crops with different costs, taking into account land-use competition between different crops.
 - Rape oil as an intermediate product that also can be imported or traded.
 - Ethanol production from sugar as well as from starch crops
 - the available potential of bioenergy, taking in mind sustainability issues. The main sources of data for bioenergy are a number of studies contacted by ECN.



Pan European TIMES Model

Biomass and Biofuels Trade

Biofuels

- Biodiesel, Bioethanol, Methanol, FT-diesel, Ethanol and DME

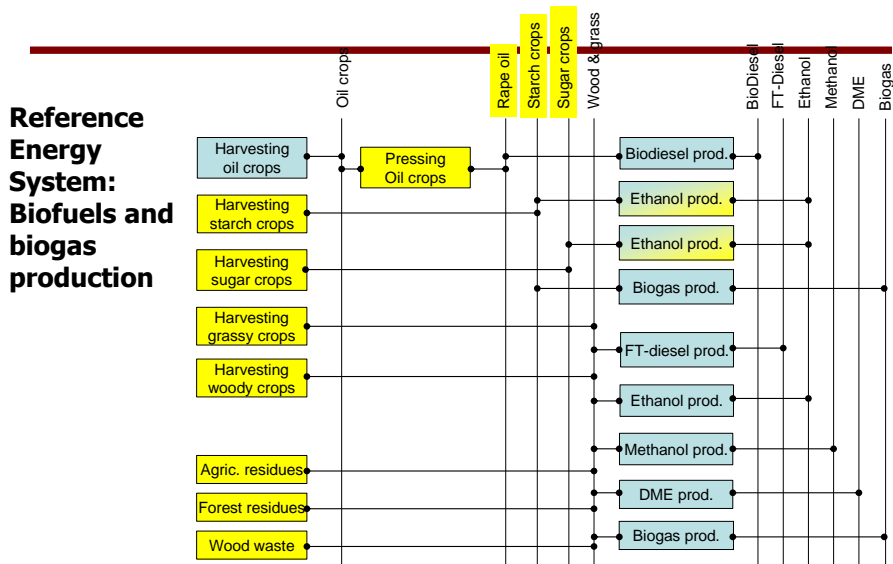
Biomass

The trade is based on:

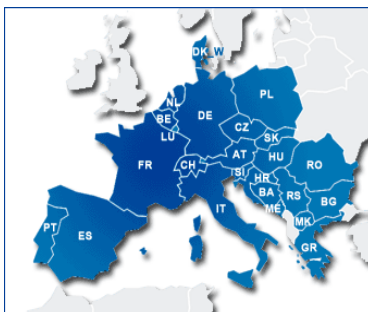
- land trading (countries with physical borders), and
 - sea trading (countries with harbors)
- So every country that has a harbor can trade with every other country that has a harbor.
- For each trade there is a associated cost



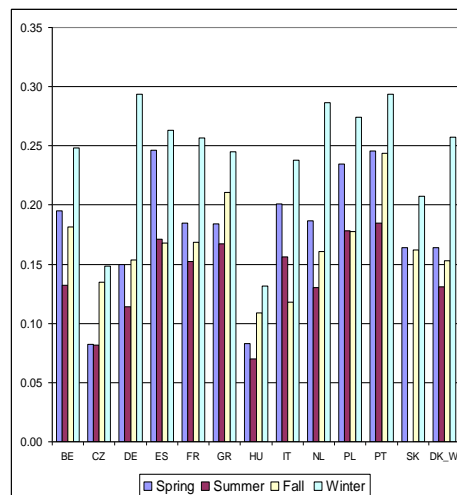
Pan European TIMES Model



Overview of the data sources Wind Availability factor



UCTE:
Monthly statistics for wind
production since 2005
EWEA:
Wind capacities by end of year.



Data sources

Bioenergy Potential

The technology characterization, the estimation of potentials for biofuels on the level of individual technologies, and the renewable heating/cooling is based on the BRED study (Biomass strategies for greenhouse gas emission reduction) and ECN's BIOTRANS model (REFUEL project - www.refuel.eu).

The data on bioenergy potentials and costs originate from the European IEE project REFUEL. In RES2020 the potentials from the REFUEL Baseline scenario are used, which describes 'most likely' developments under current policy settings. Baseline assumes a continuation of current self-reliance levels in Europe's aggregate food and feed commodities.



Data sources

Land availability

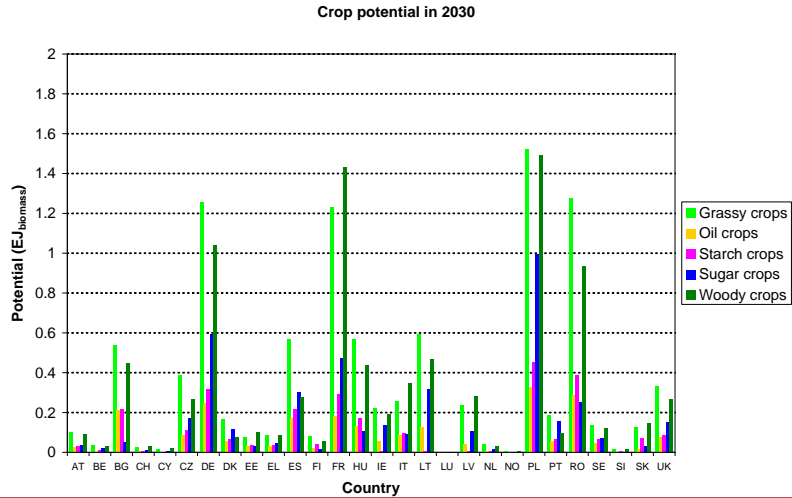
Competing land use requirements for Europe's food and livestock sector as well as land use conversion from agriculture to other uses, in particular built-up and associated land areas, will determine future availability of land for energy crop production.

Future food and feed area requirements are the result of developments in food demand combined with changes in production intensity and trade of agricultural products. Moreover, areas of high nature conservation value are excluded from the potential biofuel crop area. All these data were adopted from the REFUEL project (www.refuel.eu).



Data sources

Potentials bio-energy crops EU

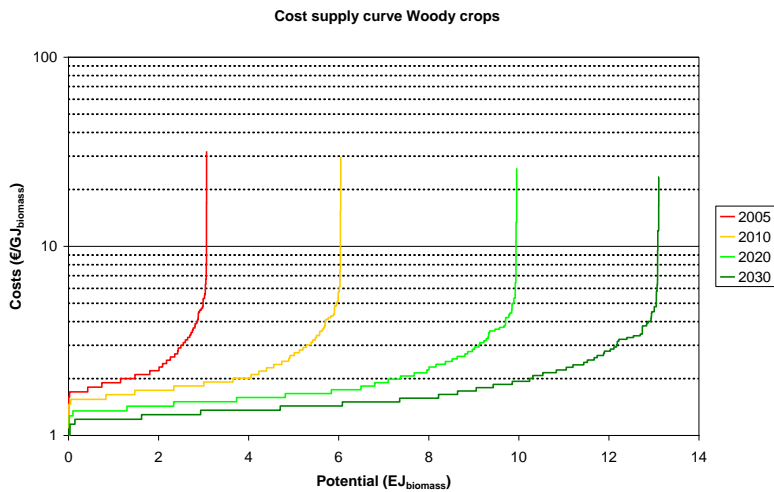


Source: Refuel Project, www.refuel.eu



Data sources

Cost supply curve woody crops EU



Source: Refuel Project, www.refuel.eu



Data sources

Other Renewable Energy Sources data

The sources used for the RES technology characterization and corresponding potential are:

- Data for **Hydropower** is an EURELECTRIC forecast which can be found in: "**EURELECTRIC** (2006): Statistics and prospects for the European electricity sector, EURPROG 2006"
- **Wind data** is an EWEA forecast (with good policies implemented) from the **TRADEWIND** project. The reference document is "Wind Power capacity data collection", April 2007, <http://www.trade-wind.eu/>



Data sources

Other Renewable Energy Sources data

The sources used for the RES technology characterisation and corresponding potential are:

- Data for the potential of **Geothermal, PV, Biogas and Ocean power** (Wave and Tidal technologies) come from the **OPTRES** forecast. The reference document "OPTRES - Potential and cost for renewable electricity in Europe", EEG, ISI, LEI, Vienna, February 2006, can be found at <http://www.optres.fhg.de/>
- Data for the potential of **Concentrated Solar Power** come from the EREC/Greenpeace scenario with good policy implemented.



Data sources

By potential in this model we mean the “Upper bound” of installed capacity per year.

The model will decide if the installation of a technology will happen based on the least cost of the energy system.



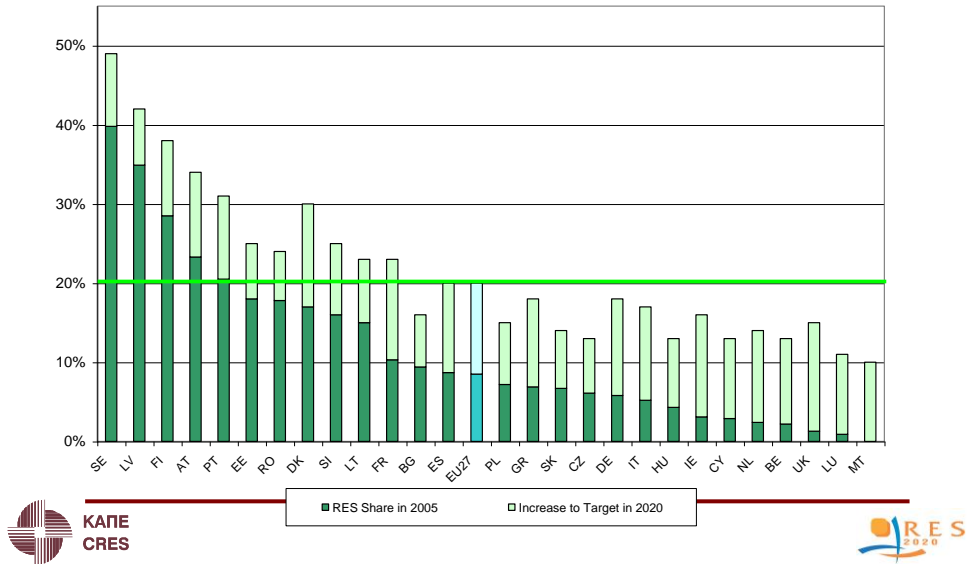
Policies applied

The existing policies per country were included in the model (i.e countries that use one policy instrument continue to use it in the time horizon of the model).

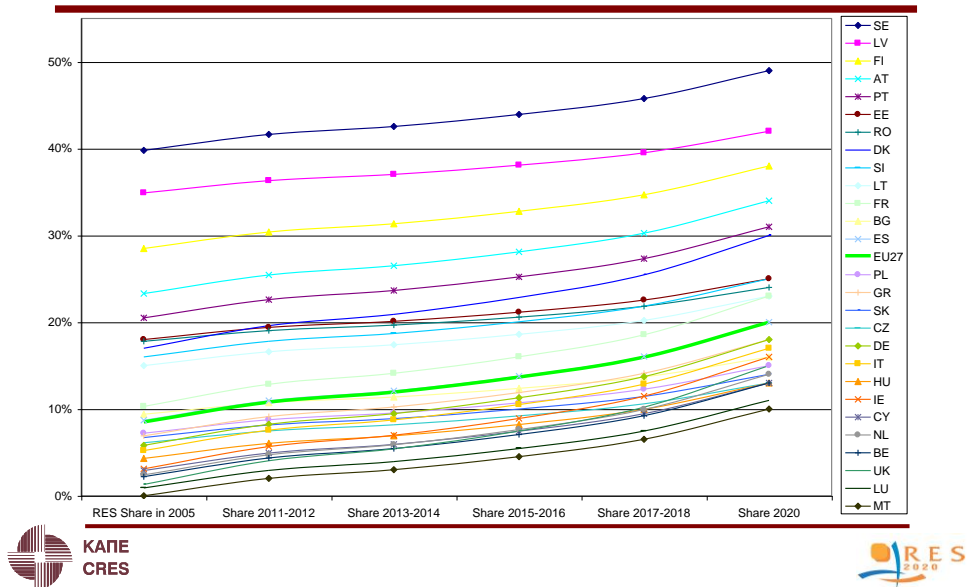
The three existing basic mechanisms were used: Feedin tariffs, Quota, Subsidies (tax or initial investment subsidies), per country as described in the “Reference Document on RES Policy and Potential”



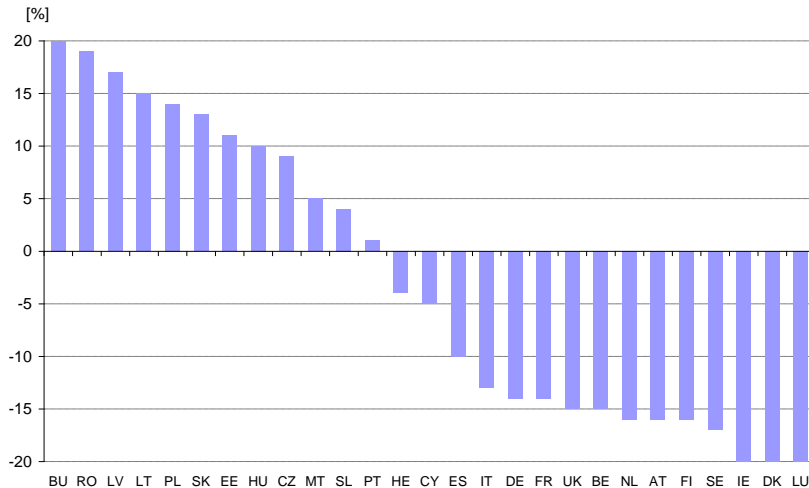
RE - Targets



RE Targets - Trajectory



Emission reduction targets for non-ETS sectors in 2020



Relative to 2005, as specified in the Energy and Climate package



PanEuropean TIMES

Four Scenarios were analyzed in the project:

1. Reference - BaU
2. RES Reference
3. REST- Statistical Transfers
4. RES-30



KAPÉ
CRES



PanEuropean TIMES

BaU Scenario Basic Assumptions:

The same background assumptions as the Baseline Scenario in the: “European energy and transport: Trends to 2030 – Update 2007” as published by DGTREN.

But for the prices of conventional fuels the forecast of World Energy Outlook 2008 (published by IEA in November 2008) are used.

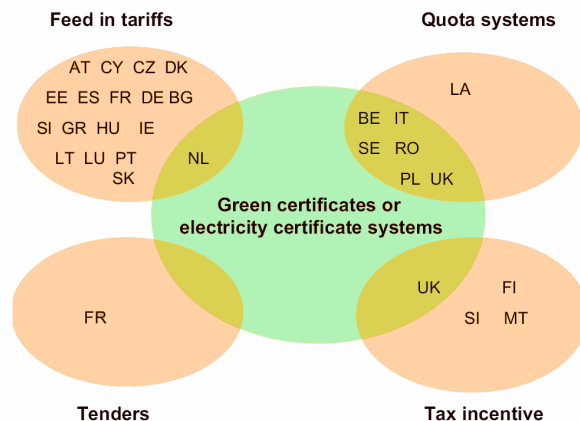
This is the scenario where the existing policies only are implemented, and their effectiveness is examined.



PanEuropean TIMES

BaU Scenario Basic Assumptions:

Include the existing policies in RES



PanEuropean TIMES

Scenario RES Reference (RES Ref)

This is the scenario where the target for renewables for each Member State is imposed, together with the target of GHG emission reduction of 20% by 2020.

The results of this scenario show the way of achieving the targets with the least cost over EU27 – given the constraints of potential per technology.



KAPE
CRES



PanEuropean TIMES

Scenario RES-Statistical Transfers (REST)

The results of this scenario show the way of achieving the targets with the least cost over EU27 and with the use of the statistical transfer mechanism that is foreseen in the Directive.

This is done on an economic optimisation basis.



KAPE
CRES



PanEuropean TIMES

Scenario RES-30

In this scenario the reduction of GHG emission by 30% in 2020 is analysed, together with the existing renewables target.

The results present the least cost way of achieving these targets over EU27.

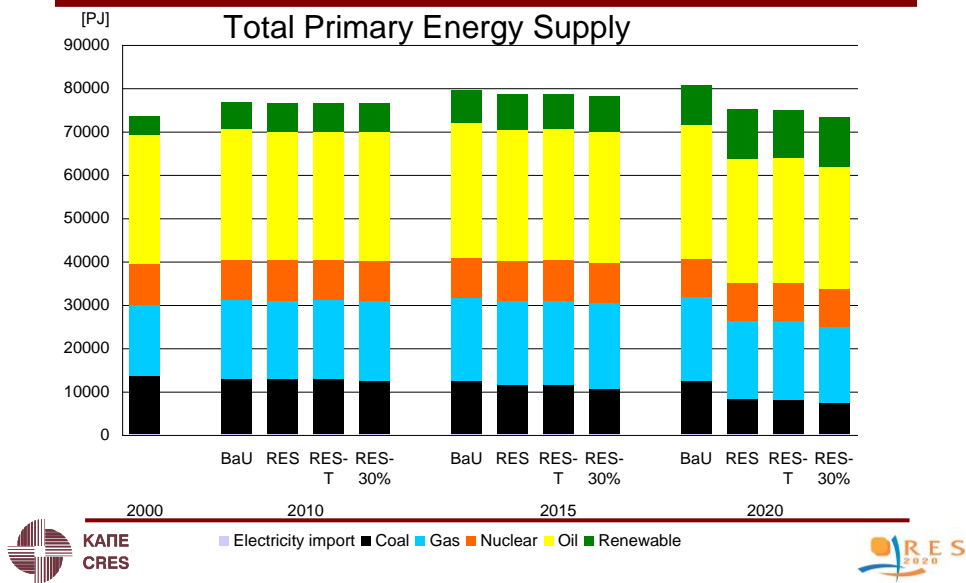


RES2020

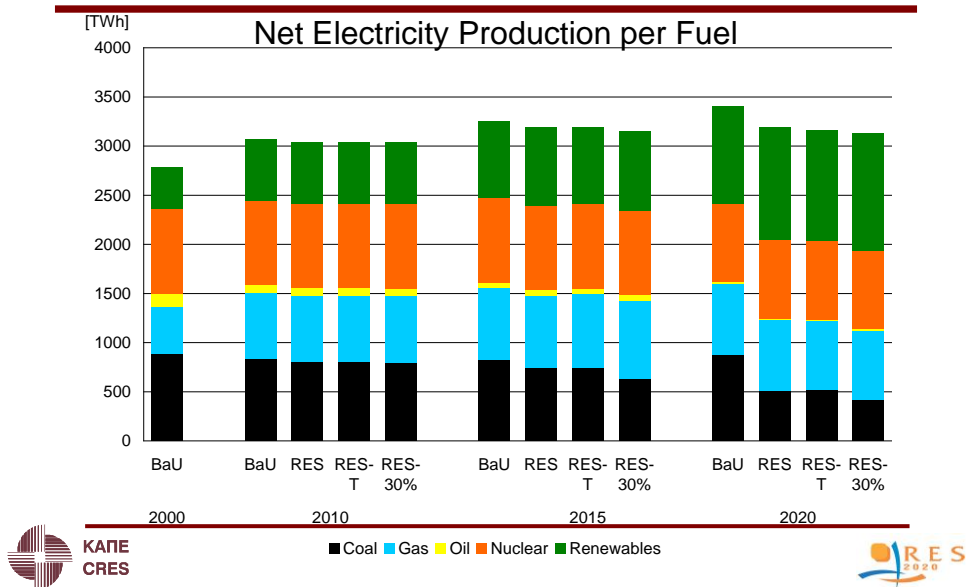
Scenario Results on the EU27 level



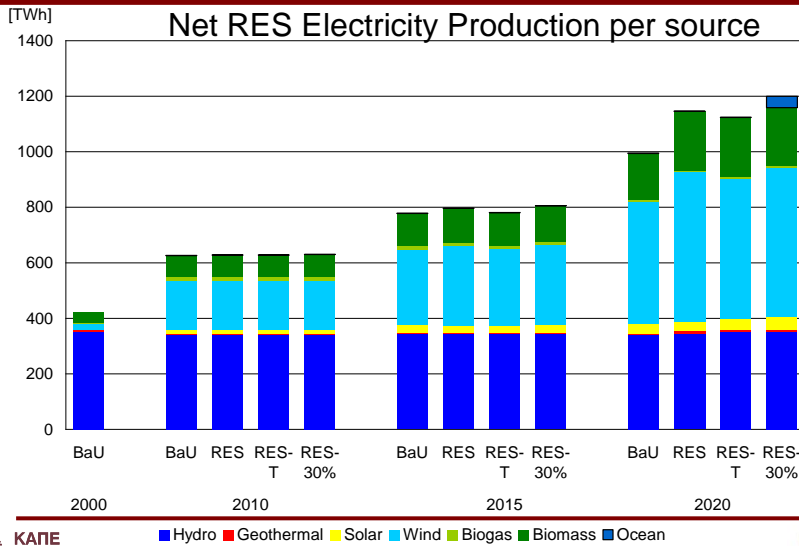
PanEuropean TIMES – EU27



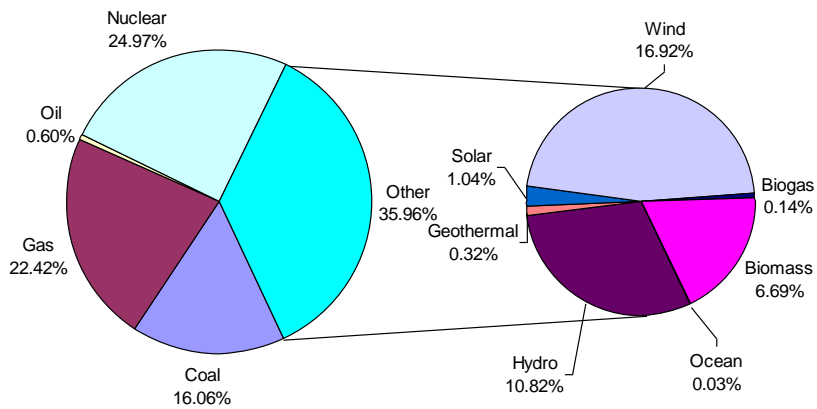
PanEuropean TIMES – EU27



PanEuropean TIMES – EU27



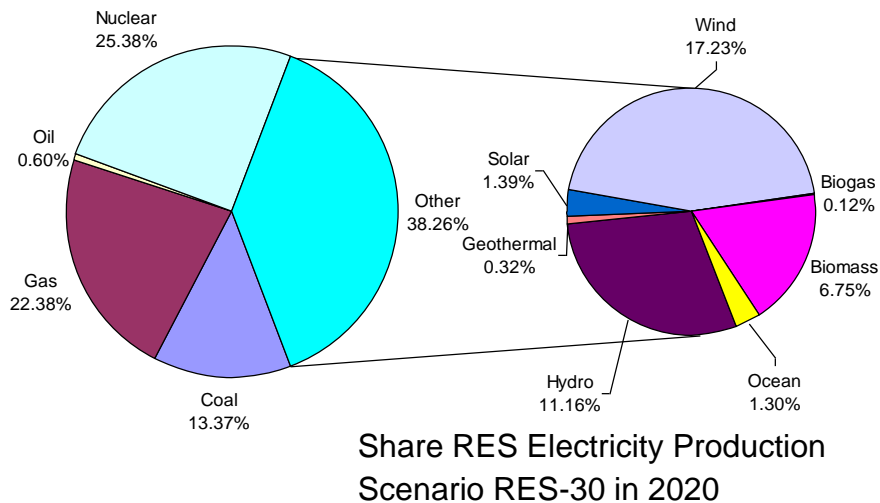
PanEuropean TIMES – EU27



Share of RES Electricity Production in the total Net Electricity Production -Scenario RES-Reference in 2020



PanEuropean TIMES – EU27

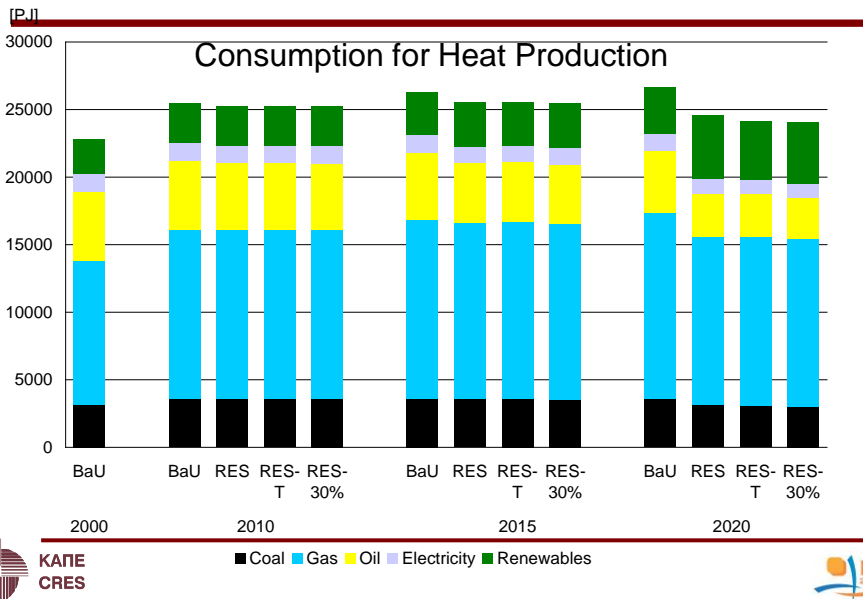


PanEuropean TIMES – EU27

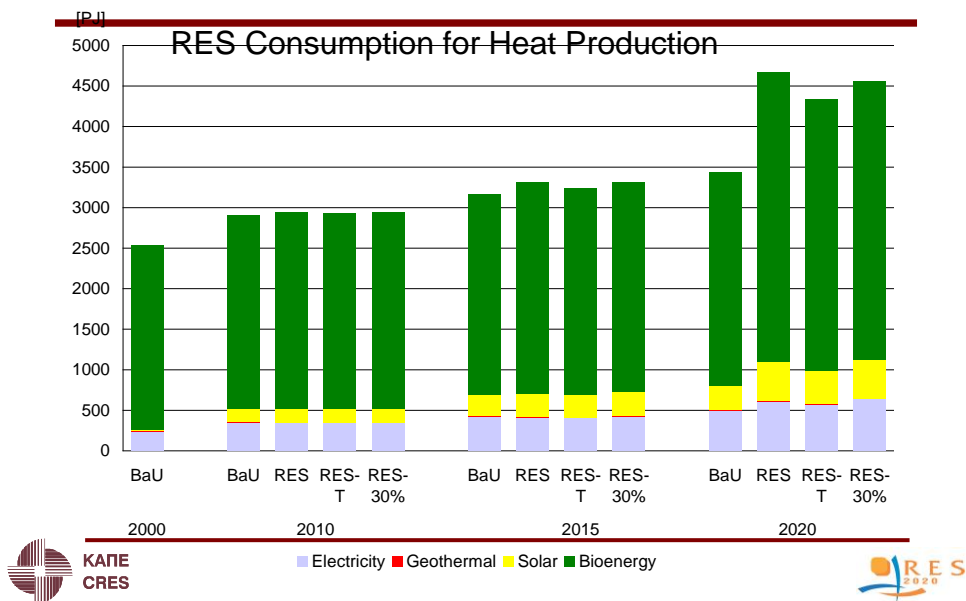
- In the Electricity production sector it is Wind and Hydro that dominate the scene.
- Bioenergy is preferred to be used in the final energy because of the way the target of Renewables is imposed



PanEuropean TIMES – EU27

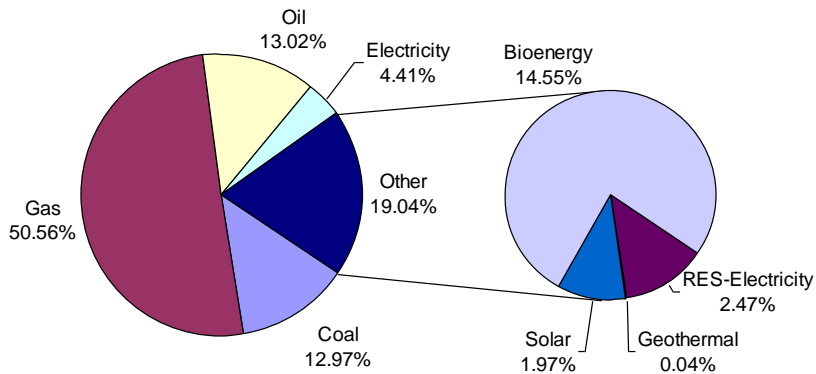


PanEuropean TIMES – EU27



PanEuropean TIMES – EU27

RES Consumption for Heat Production in 2020



PanEuropean TIMES – EU27

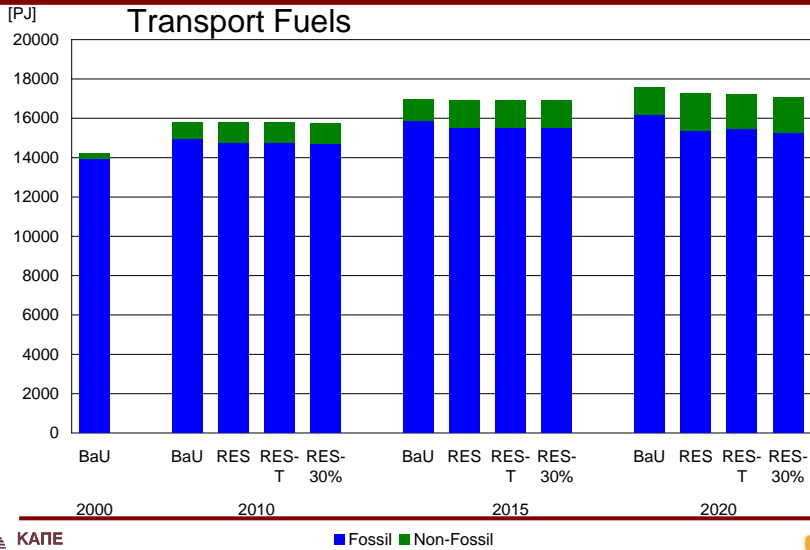
Bioenergy plays an important role in heat production, and is mainly used in:

- Industrial CHP
- District Heating
- High efficiency boilers in residential and tertiary sector.

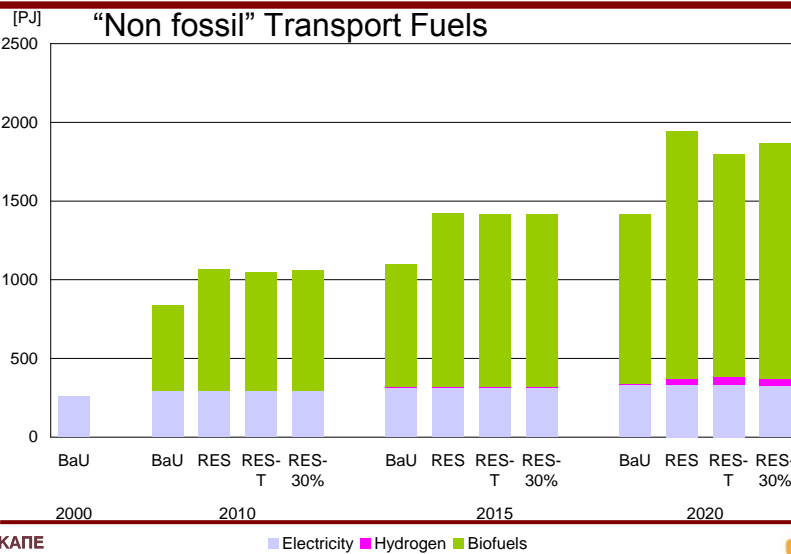
The largest share of bioenergy comes from woody and grassy crops, agricultural waste and forestry residues.



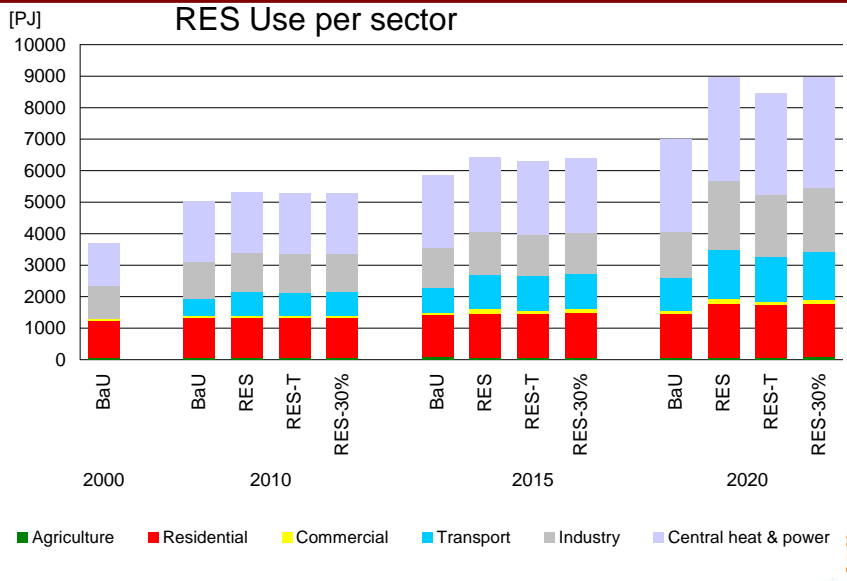
PanEuropean TIMES – EU27



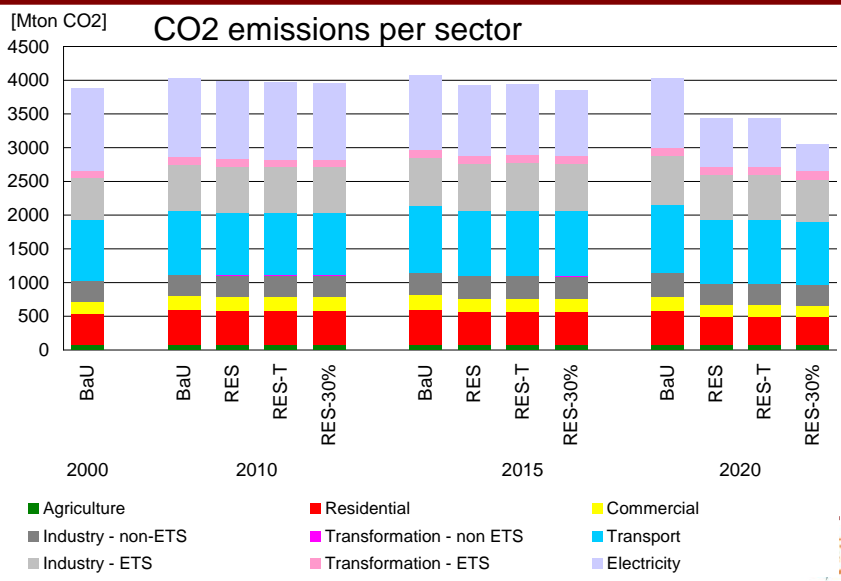
PanEuropean TIMES – EU27



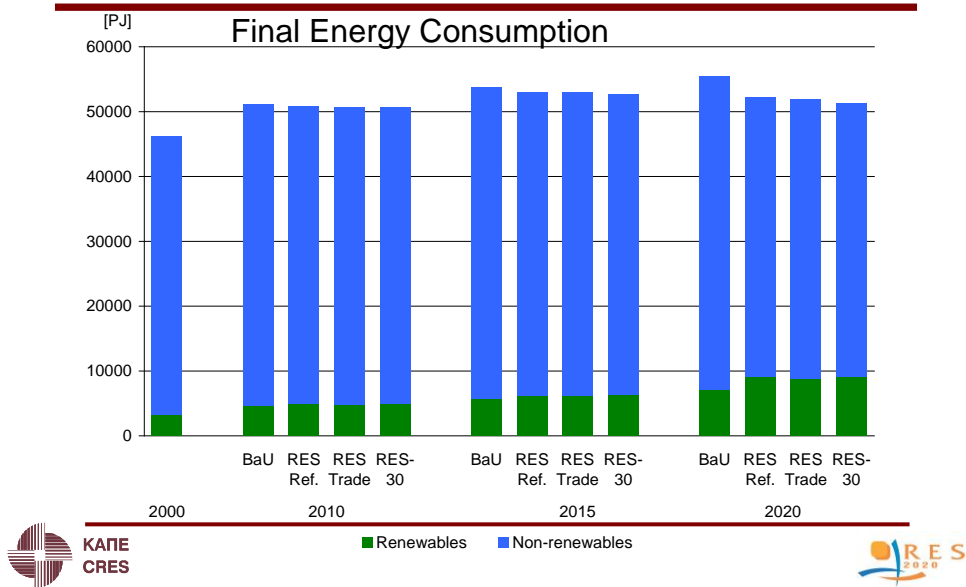
PanEuropean TIMES – EU27



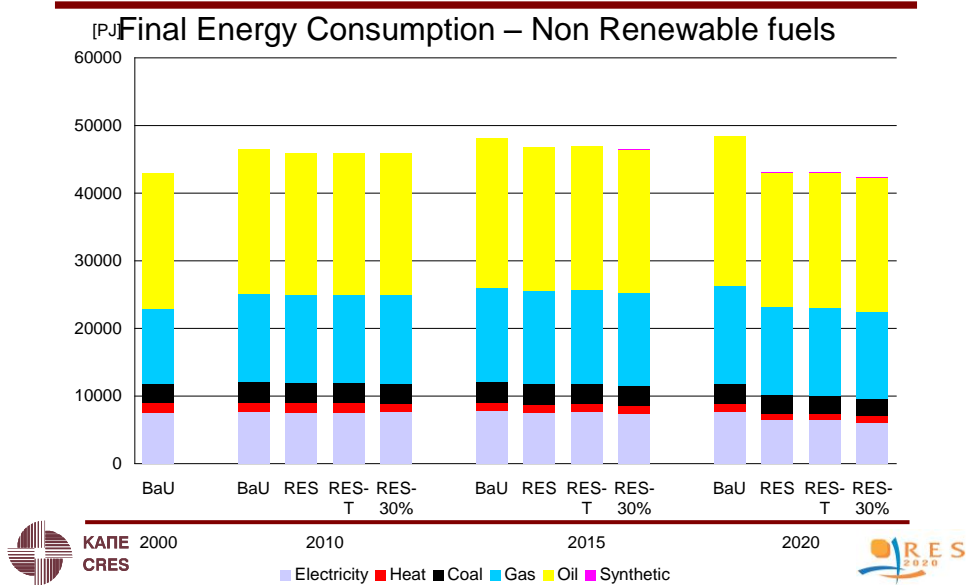
PanEuropean TIMES – EU27



PanEuropean TIMES – EU27



PanEuropean TIMES – EU27



PanEuropean TIMES – EU27

Final Energy Consumption – Conventional fuels

A reduction of the use of conventional fuels compared to the BaU scenario, is due to the combined effect of energy savings and use of RES.

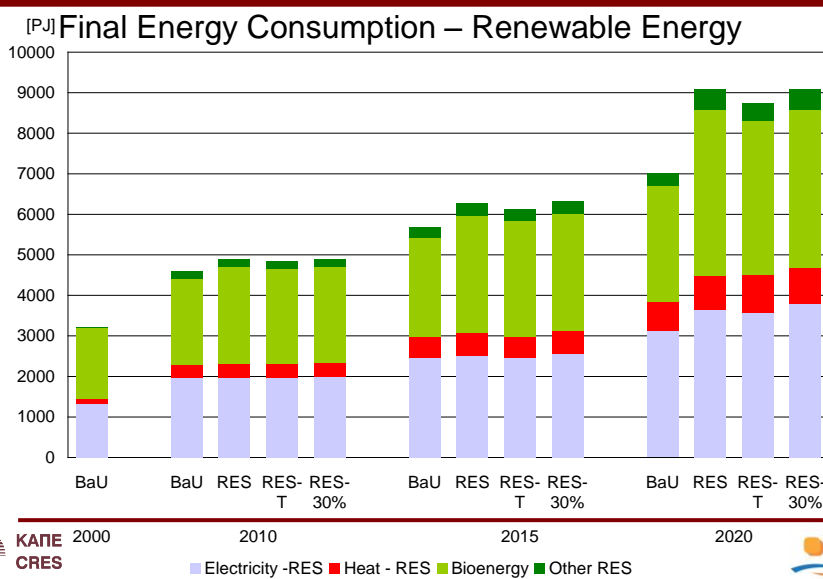
There is:

- a reduction of the use of N. Gas by 9%-11%
- a reduction of Coal by 11%-18%
- a reduction of Oil products by 10%-12%

The energy savings are consistent with the targets of the ESD directive.



PanEuropean TIMES – EU27



PanEuropean TIMES – EU27

Final Energy Consumption – Renewable Energy Sources

In the policy scenarios there is

- 28%-35% more bioenergy
- 40-60% more solar for hot water
- 20-27% more geothermal
- 30% more district heating from renewables (mainly from bioenergy)

in the Final Energy Consumption compared to the BaU scenario



PanEuropean TIMES – EU27

Sensitivity Analysis to check the robustness of the results:

The availability of all biomass types was reduced to respectively 50%, 25% and 10% of the original assumptions.

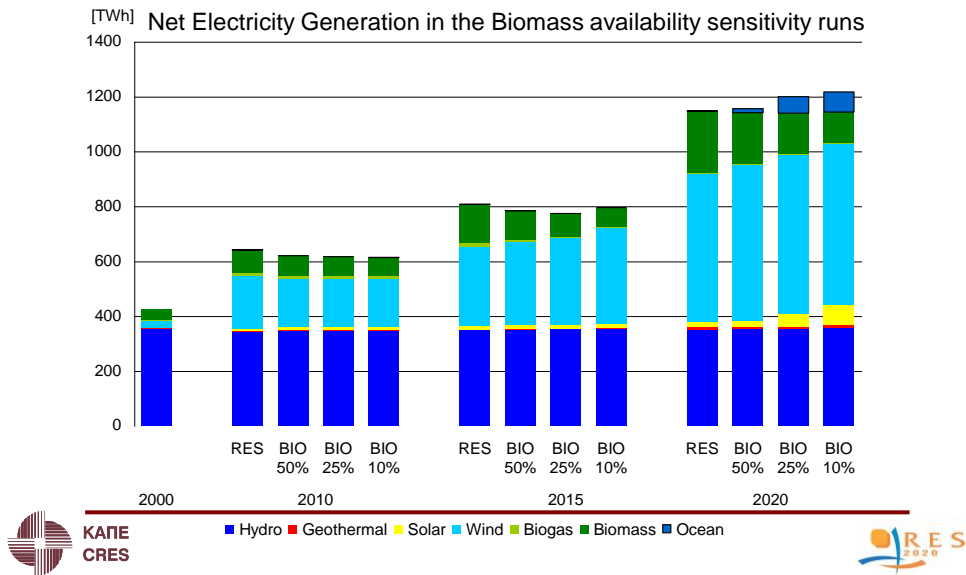
The potential of wind energy was varied, with two runs in which it was set at 75% and 125%, respectively.

The international price of oil was increased to the high price scenario of the DoE AEO2009

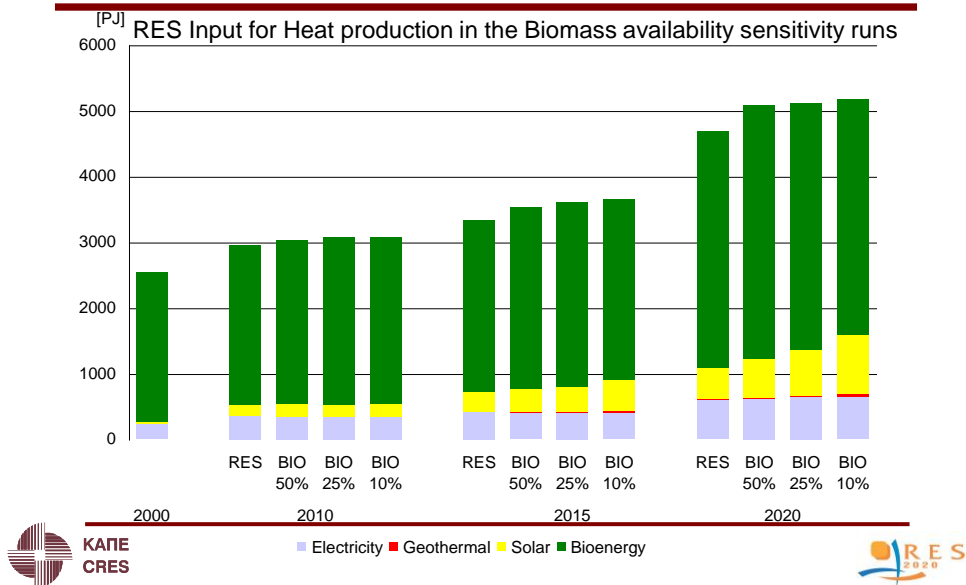
The useful energy demand was varied in a scenario without elastic demands.



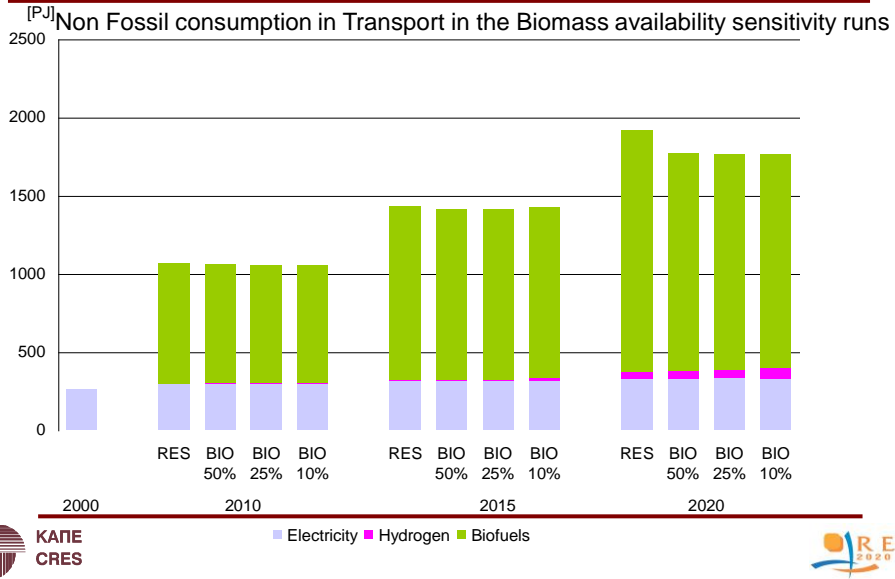
PanEuropean TIMES – EU27



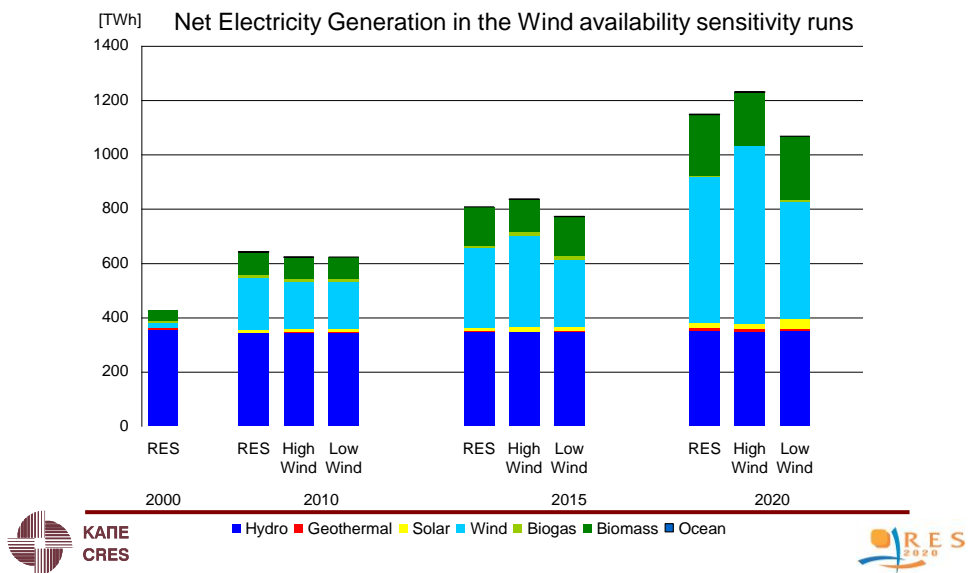
PanEuropean TIMES – EU27



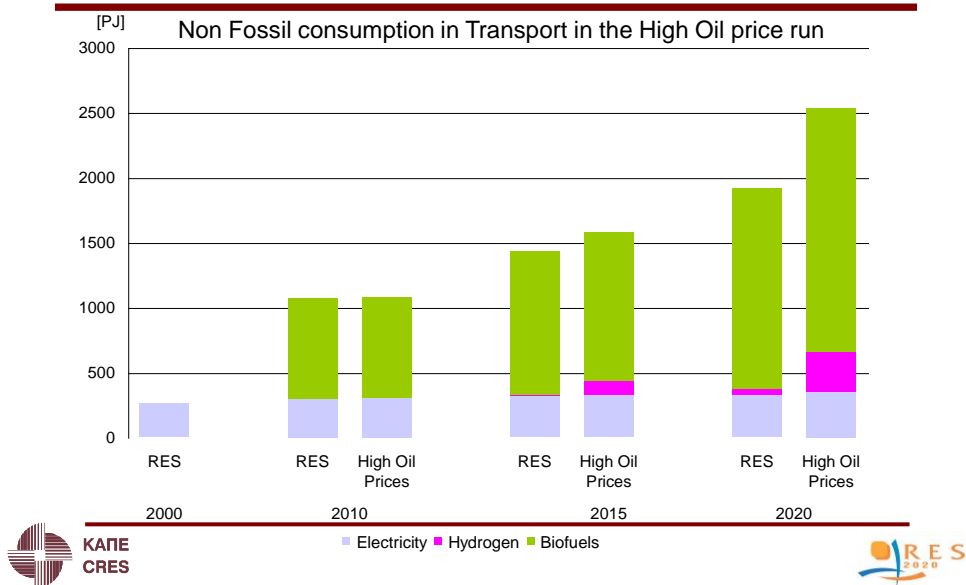
PanEuropean TIMES – EU27



PanEuropean TIMES – EU27



PanEuropean TIMES – EU27



PanEuropean TIMES – EU27

Conclusions

The target for RES can be met by:

- ~36% Electricity production from RES (Largest share Wind and Hydro)
- ~20% Heat production from RES (Largest share bioenergy)
- ~10% Renewable in transport (largest share of which is biofuels)


Thank you..

ggian@cres.gr

More Information:

www.res2020.eu

The project was co-funded by the Intelligent Energy Europe Programme.
The sole responsibility of the content lies with the authors, it does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained herein.

Intelligent Energy  Europe

