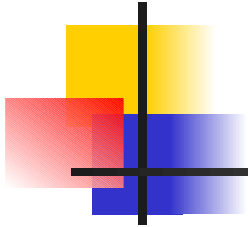


THEMATIC NETWORK CLEANER & MORE EFFICIENT GAS TURBINES (CAME-GT)

CONTRACT NO: ENK5-CT-2000-20062

First International Conference

10-11 July 2003, Brussels

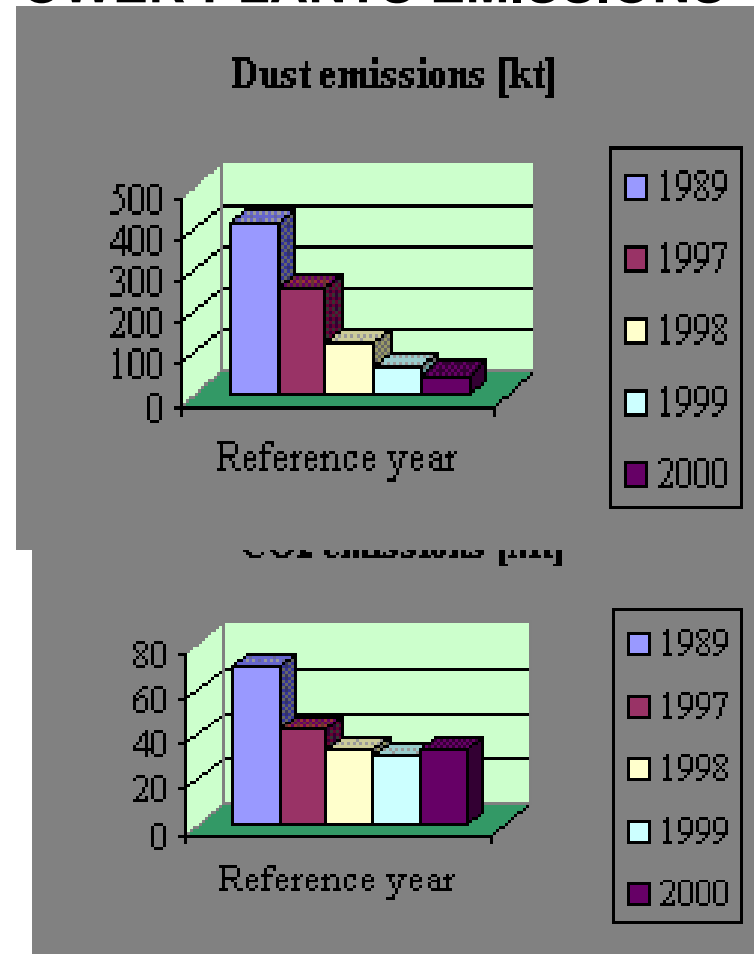
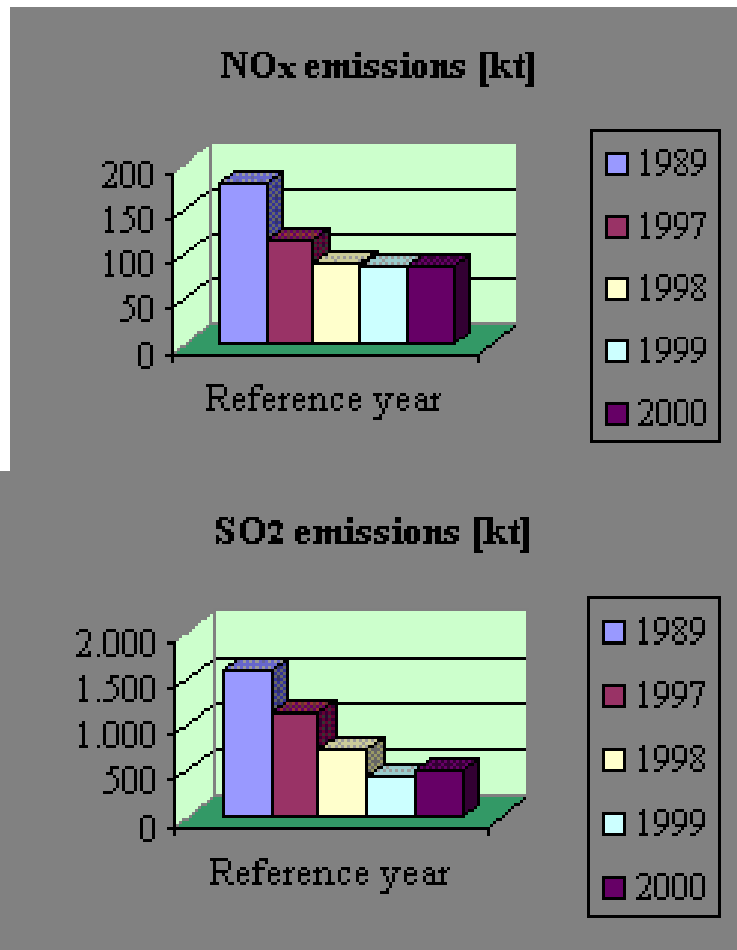


MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

Dr. Adrian ADAM
Adina BOSOAGA
Silvia PRUNDIANU

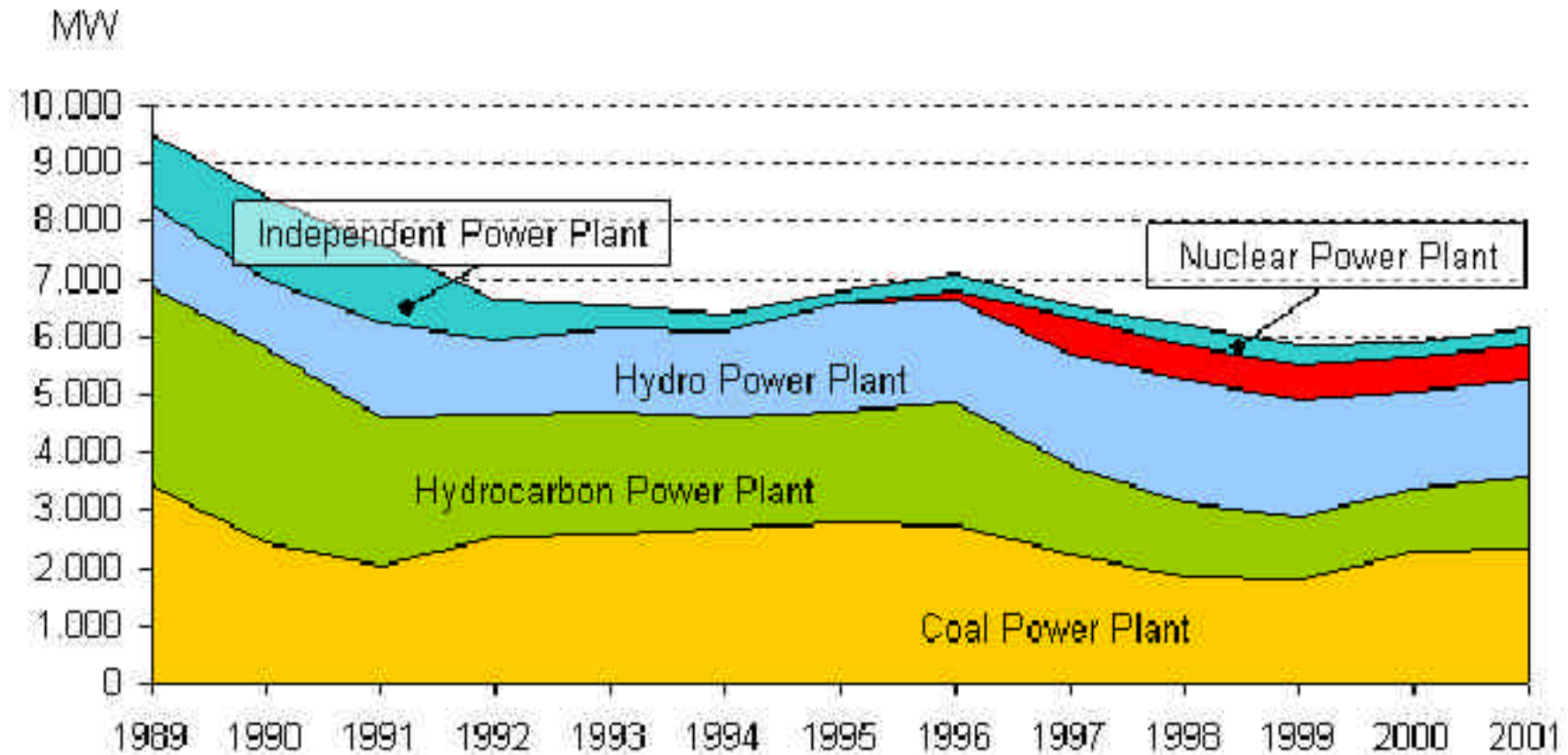
MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

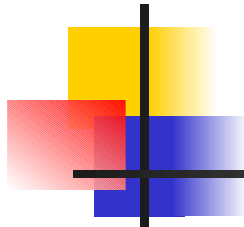
MITIGATION OF THERMO-POWER PLANTS EMISSIONS



MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

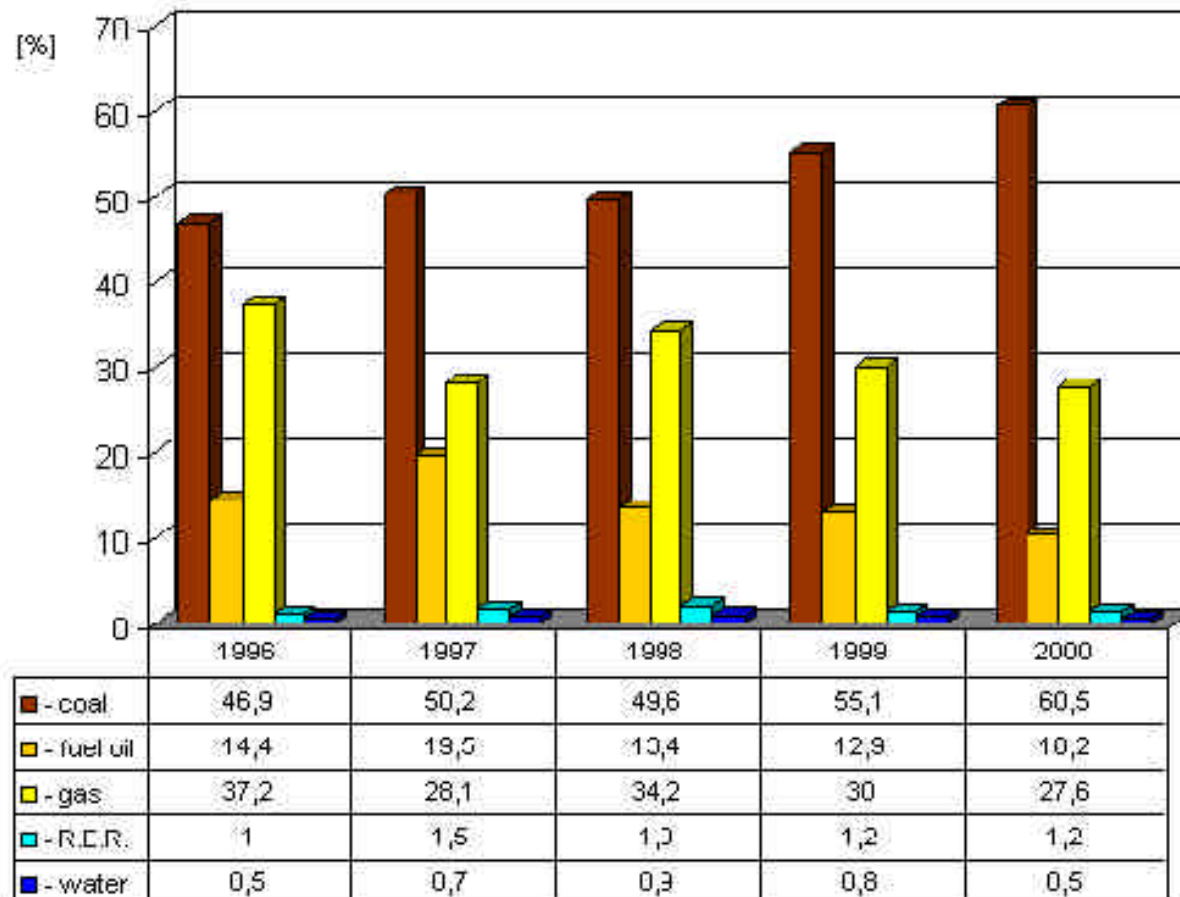
GENERATED ELECTRIC POWER [%]

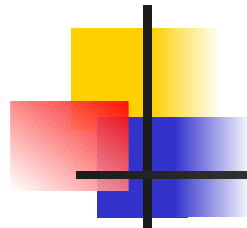




MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

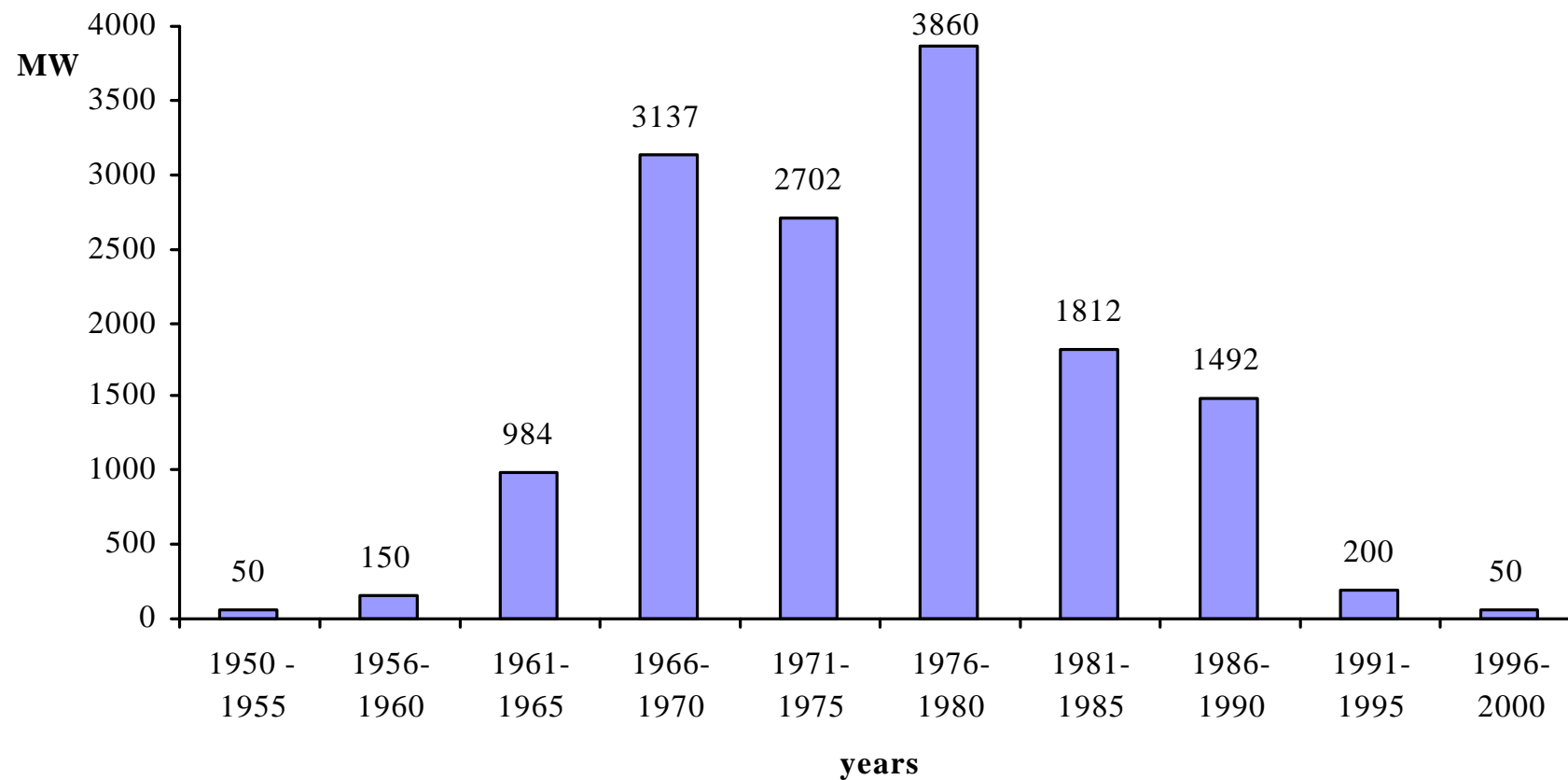
ELECTRICITY PRODUCTION BY TYPES





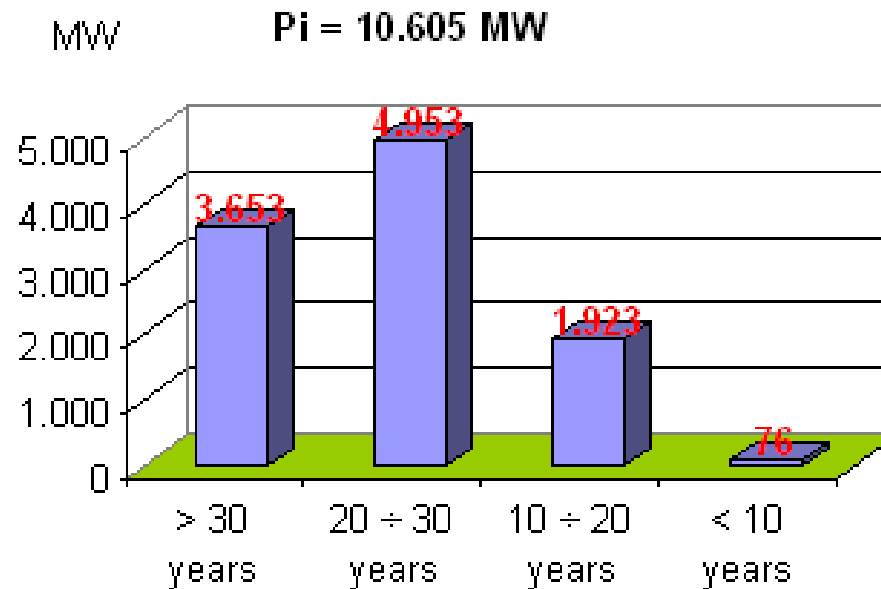
MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

DYNAMIC OF INSTALLING NEW CAPACITIES IN THE ROMANIAN TPPs



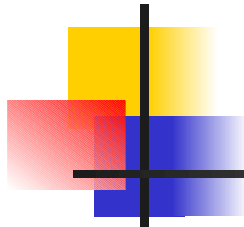
MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

POWER PLANT AGES



Over 82% of the installed capacities in Termoelectrica's generating park are older than 20 years, with obsolete technologies at '60÷'70's level which lead to:

- Low performances and high production costs;
- I&C low performances, which don't reach the UCTE requirements;
- Emission levels that don't meet the EU requirements.

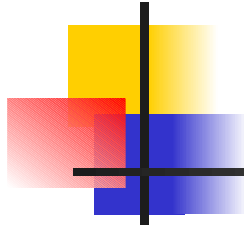


MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

OVERALL PERFORMANCES IN ROMANIAN TPPs – years 1999 and 2000

Year	1999	2000
Generated electricity, GWh	25 054,9	29 625,0
Gross efficiency, %		
- TPPs running on coal	33,0	33,2
- TPPs running on hydrocarbons	42,6	43,2
- Total	36,0	35,9

- The efficiencies obtained in the Romanian TPPs are quite low.



MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

ROMANIAN RESEARCHES DIRECTIONS IN GAS TURBINES TECHNOLOGIES PROMOTION DOMAIN

Achievement of combined cycles with high efficient gas turbines

- The research activity was mainly focused on studying the possibilities for implementing gas turbines technologies into the thermal power plants (TPP's).

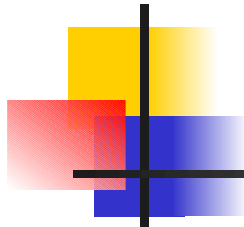
- **Development of the new CHPP's**
- **Utilization of the gas turbines for the rehabilitation of large condensing units**
- **Utilization of mini and micro gas turbines**
- **Improvements in STAG combined cycles technology**
- **Utilization of gas turbines for the rehabilitation of existing combined heats and powers plants (CHPP)**

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

MODERNIZATION OF LUDUS THERMAL POWER PLANT BY REHABILITATION OF A K-100-130 UNIT TYPE

K-100-130 performances before and before the rehabilitation

Parameter	Variant I Initial state	Variant II CCFF rehabilitation	Variant III STAG rehabilitation	Variant IV PPCC rehabilitation
ST gross electric power, kW	100 000	89 834	70 109	105 666
GT gross electric power, kW	-	23 274	154 500	13 505
Total gross electric power, kW	100 000	113 108	224 609	119 171
Steam boiler fuel consumption, m ³ N/h	27 717	19 721	-	27 631
GT fuel consumption, m ³ N/h	-	7 398	47 226	4 339
Total fuel consumption, m ³ N/h	27 717	27 119	47 226	31 970
Gross efficiency, %	38,8	44,6	50,9	39,9



MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

Gas turbines selected for the rehabilitation

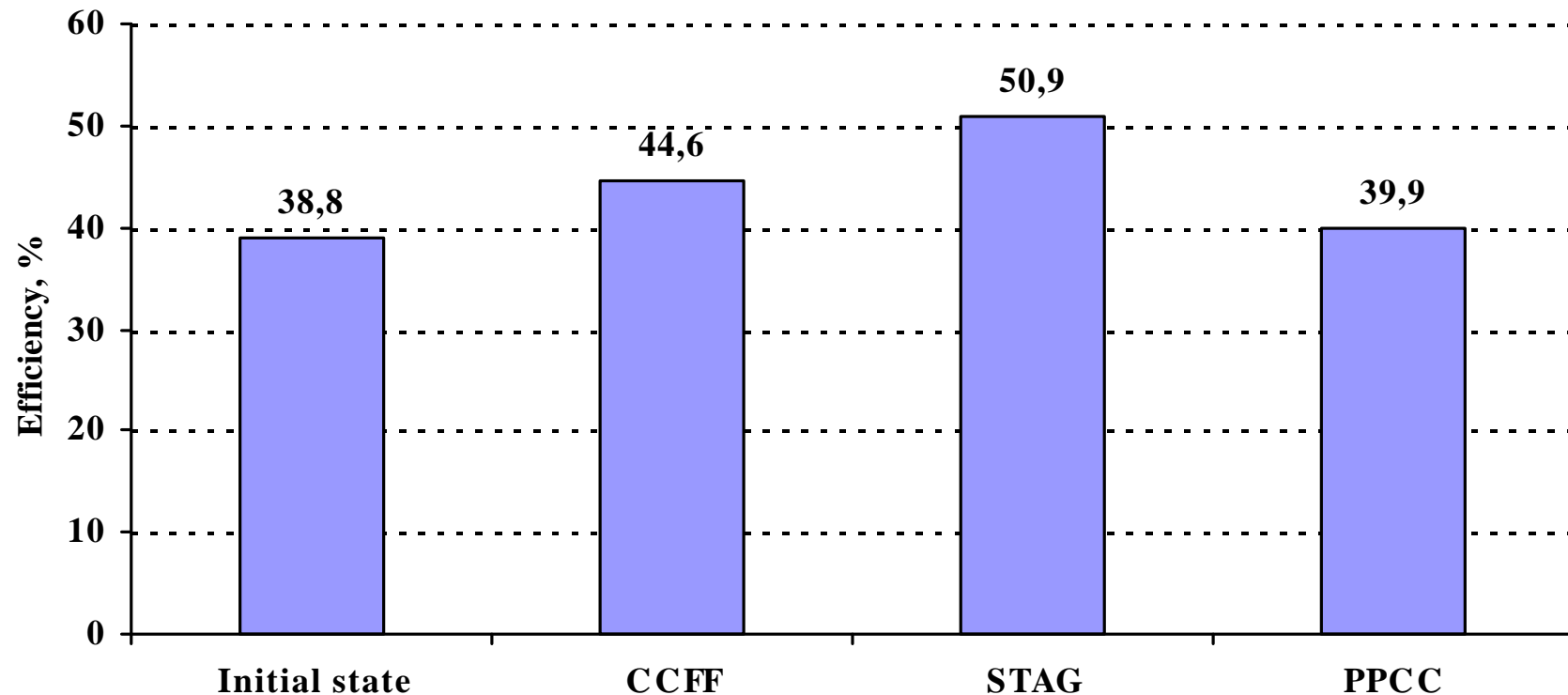
Rehabilitation variant	GT type	Manufacturer
CCFF	GT 10	Alstom
STAG	GT 13 E2	Alstom
PPCC	LM 1600	General Electric

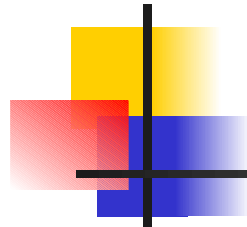
Three rehabilitation solutions by which combined cycles gas turbines are developed:

- Unfired combined cycle gas turbine (STAG);
- Combined cycle fully fired (CCFF);
- Parallel powered combined cycle (PPCC).

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

GROSS EFFICIENCIES OBTAINED AFTER THE REHABILITATION





MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

Annual energy balances for the analyzed variants

Variant	I	II	III	IV
Annual utilization of the installed power, h/year	6 000	6 000	6 000	6 000
Generated electricity, MWh/year	600 000	678 648	1 347 654	715 026
Annual fuel consumption ¹ , thousands m ³ N/year	166 302	162 714	283 356	191 820

1 - natural gas with LHV = 33 649 kJ/m³N

Annual CO₂ emission for the analyzed variants

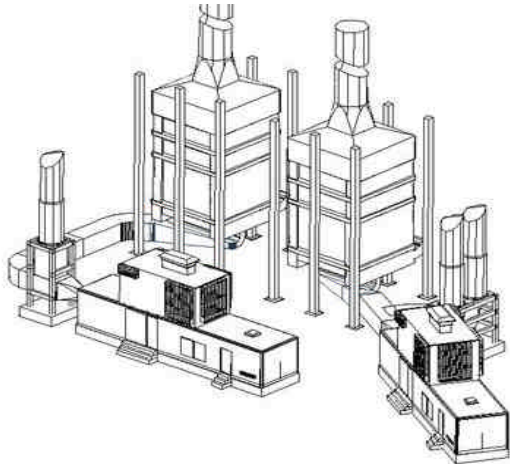
Variant	I	II	III	IV
Generated electricity, MWh/year	600 000	678 648	1 347 654	715 026
Absolute CO ₂ emission, t/year	326 617	319 570	556 511	376 734
Specific CO ₂ emission, gr/kWh	544	471	413	527
Difference of generated electricity ¹ , MWh/year	747 654	669 006	0	632 628
Fuel consumption for covering the generated electricity difference ² , t/year	1 102 640	986 650	0	933 000
CO ₂ emission resulted from covering the generated electricity difference, t/year	929 924	832 102	0	786 856
Total CO ₂ emission, t/year	1 256 541	1 151 672	556 511	1 163 590

1 Difference by respect to the reference variant (3rd variant), the difference is generated in an existing TPP running on lignite with 33 % efficiency.

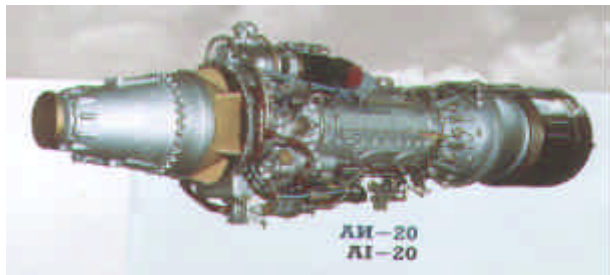
2 Lignite with LHV = 7397 kJ/kg and carbon weight by mass of 23 %

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

❑ MODERNIZATION OF BOTOSANI THERMAL POWER PLANT BY INTRODUCING GAS TURBINES COGENERATION



Cogeneration Power Plant (CPP) with two identical Units composed from electric turbo generator groups (which have been imported from Ukraine, in 1989 for the marine platforms) which would use as the recovery boiler the two existing hot water boilers.

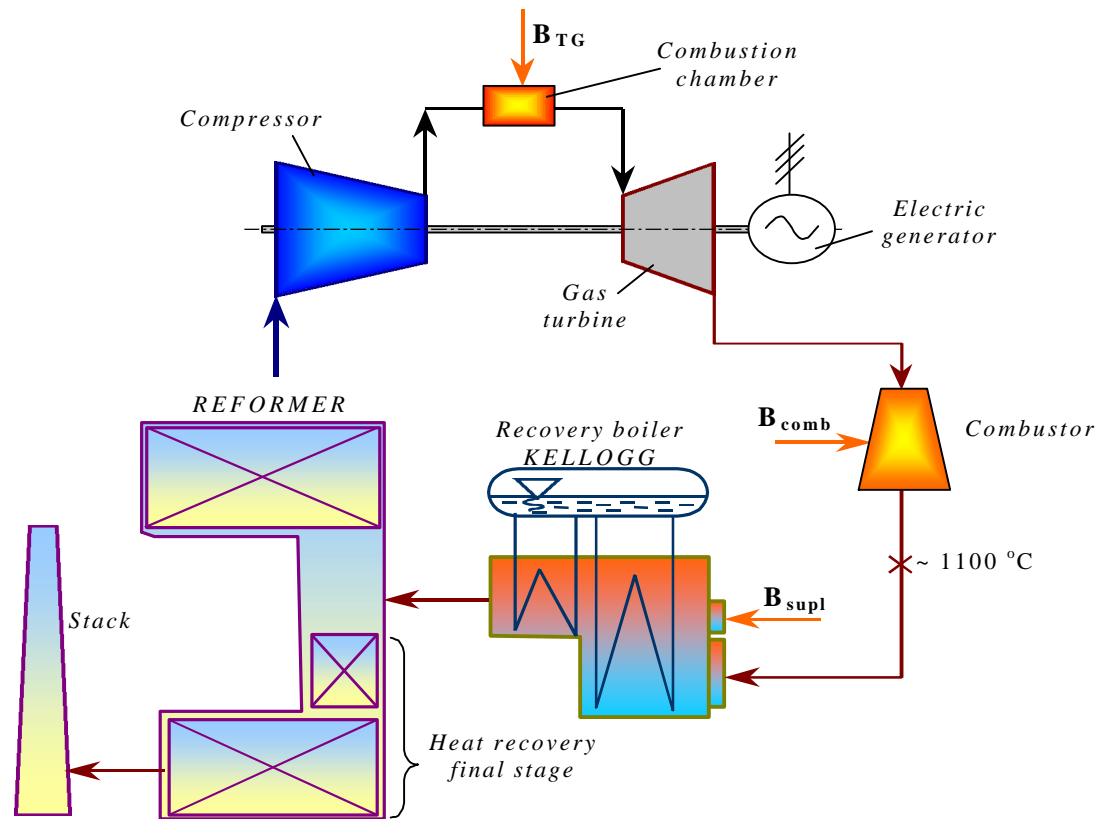


AI20 DME turboprop

The Power Unit is conceived based on the product “Mobile Electro station type PAES 2500” from the Ukrainian Company MOTOR SICH, which uses as prime mover the AI20 DME turboprop, an aero derivative product (known as propulsor for IL 18 aircraft).

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

- ❑ SC VIROMET SA VICTORIA COGENERATION PLANTS LAYOUT, INCLUDING TYPHOON-5MW GAS TURBINE, COMBUSTOR FOR SUPPLEMENTARY COMBUSTION AND RECOVERY BOILER KELLOGG TYPE

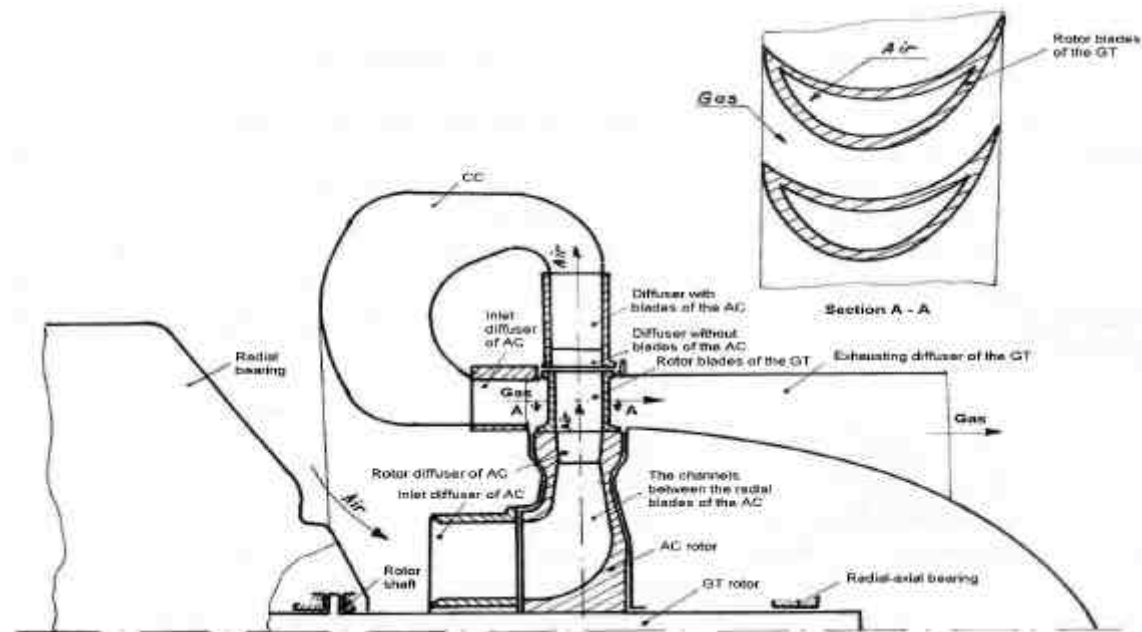


MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

THEORETICAL AND EXPERIMENTAL RESEARCH IN COMBUSTION FIELD

- main research activities in gas turbine field consist in numerical modeling of the combustion chamber and of combustion

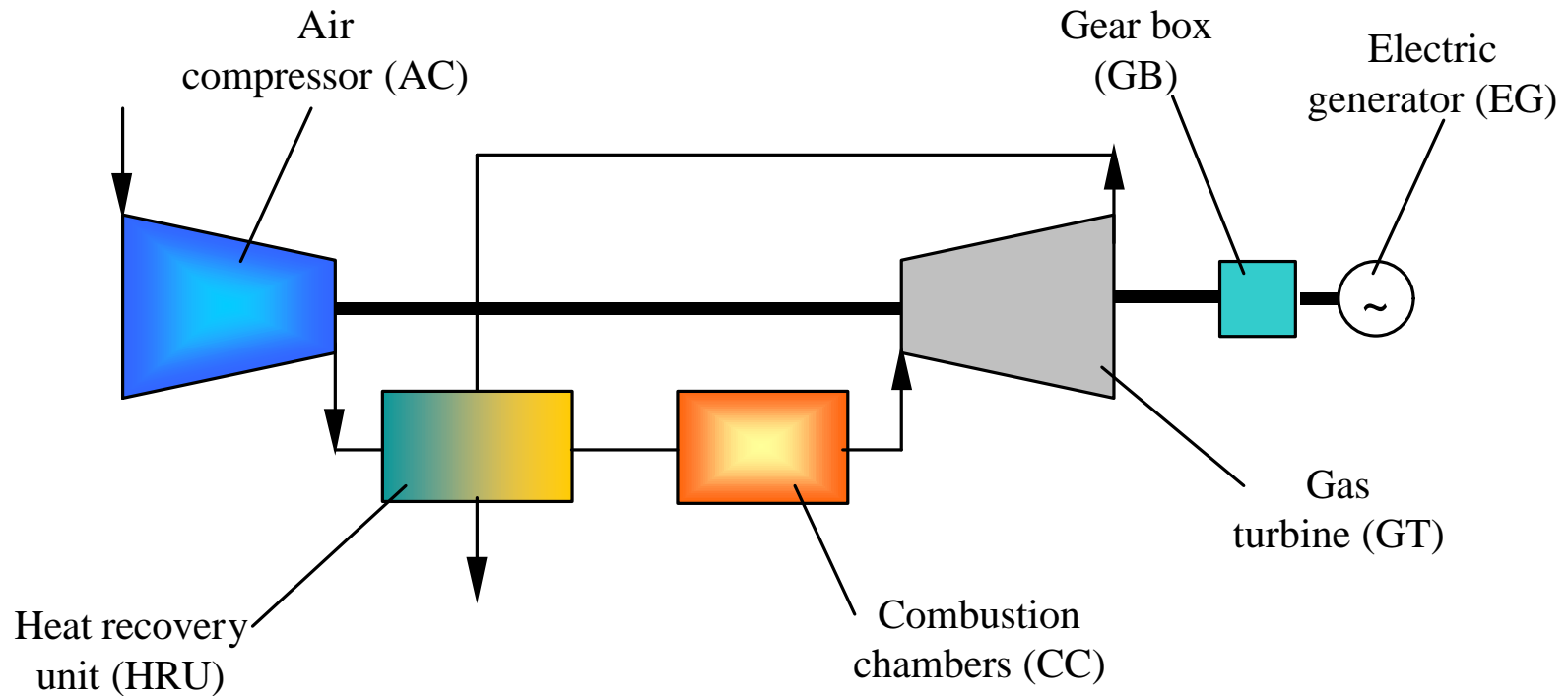
□ COMPACT GAS TURBINE INSTALLATION



Compact GTI – Simplified flow chart

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

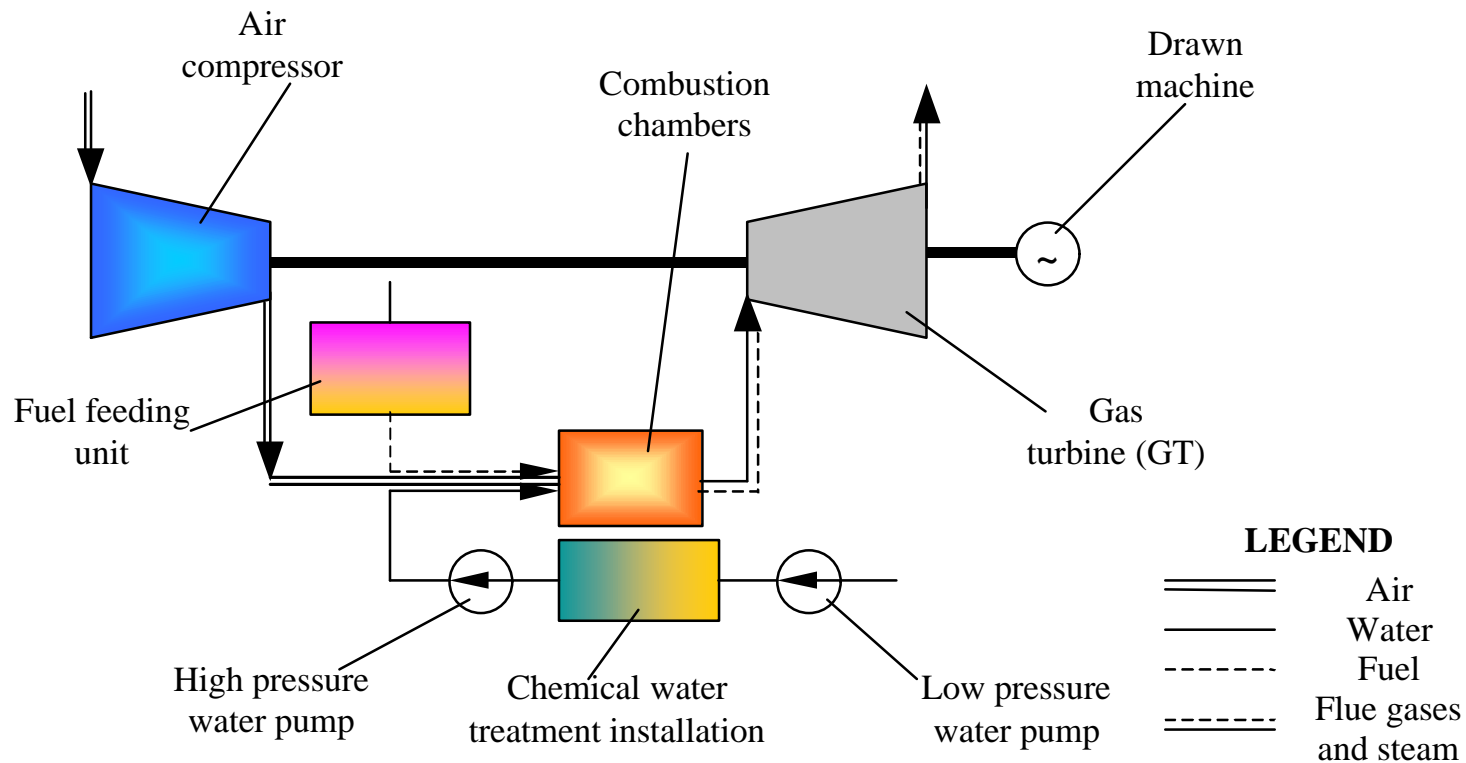
□ GAS TURBINE INSTALLATIONS WITH DIVIDED EXPANSION



Simplified schema of a GTI

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

□ GAS TURBINE INSTALLATION WITH TOTAL WATER INJECTION IN THE COMBUSTION CHAMBER



GTIWTI schematic representation

MAIN ACTIVITIES IN THE GAS TURBINE FIELD IN ROMANIA

COMBUSTION CHAMBER WITH FUEL-AIR PREMIXED COMBUSTION FOR AN AERODERIVATIVE GAS TURBINE

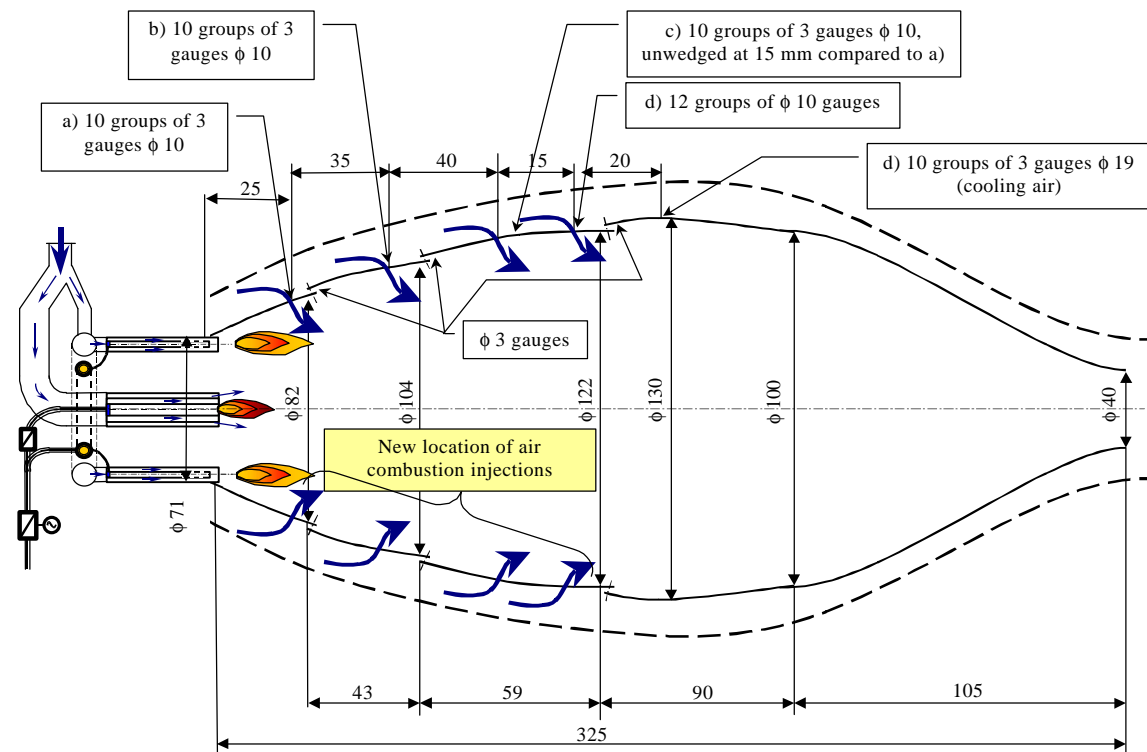


Fig.8. Scheme of the gas turbine's AI24 combustion chamber modified in second stage, functioning with fuel gas with premixed air gas