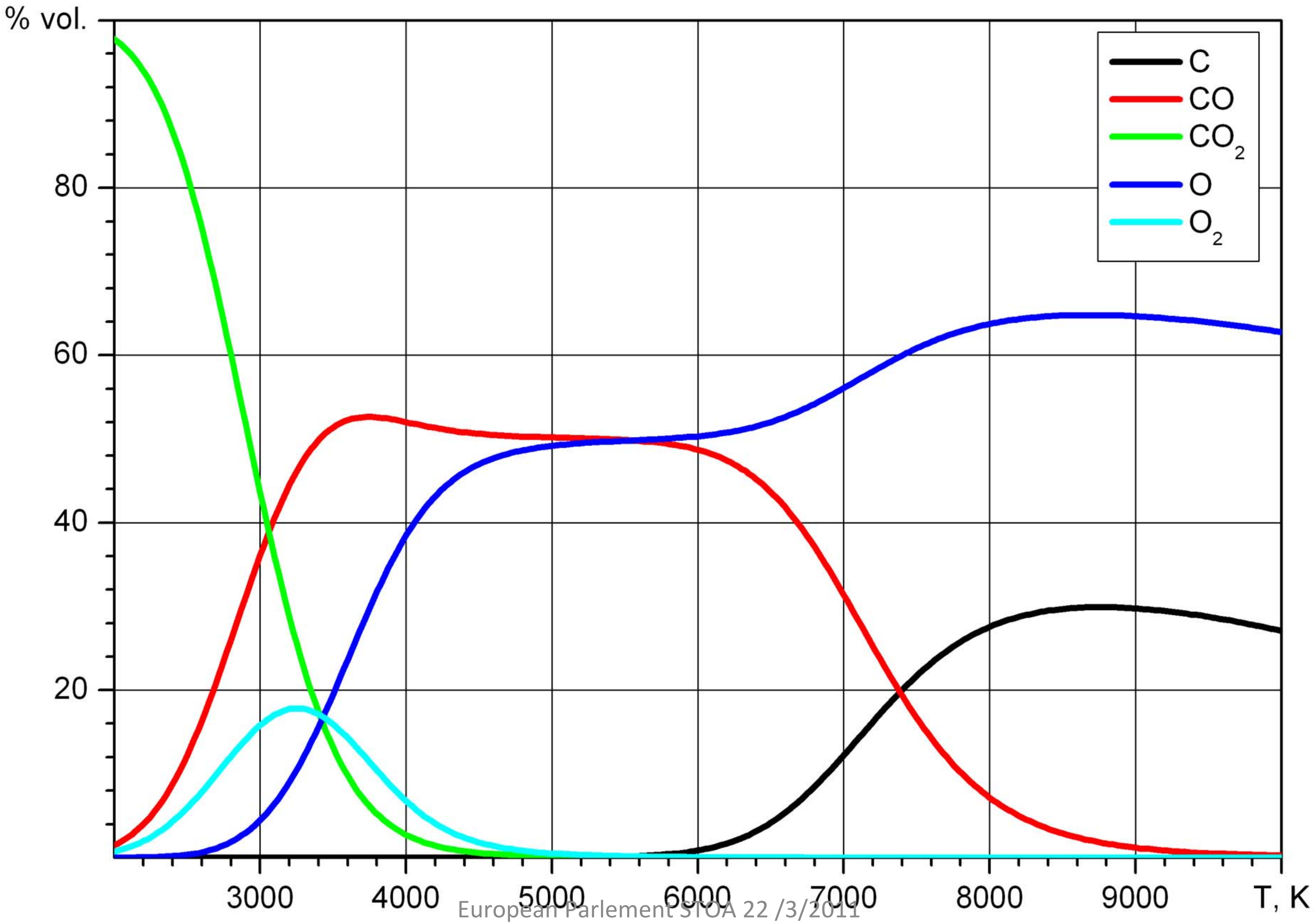
-7- (5)(Carbon dioxide and electrical arc processes

- Direct gasification of coal by CO_2 and electrical plasma torches up to 10 megawatt and few cubic meters of CO_2 per minute
- $CO_2 + C \rightarrow 2\,CO$
- Results from Professor Ph Rutberg (RAS)
- Lab of electrotechnic and electrophysic
- State Polytechnic University of Saint Petersburg Russia

specific properties of plasma reactors for a direct electron energytransfert

- **direct energy transfert from electron to carbon dioxide orbitals that mean direct excitation states**
- **excitation states** depend of the **equilibrium or non equilibrium factors** such as the pressure,chock wave,hydrodynamic flow mixing...
- **main advantages**:***short residence time*** and very **short starting reactor time** which are in agreement with discontinuous processes

CO_2 thermodynamic COMPOSITION (1atm)



Electron excited mechanisms for CO_2 dissociation efficiency

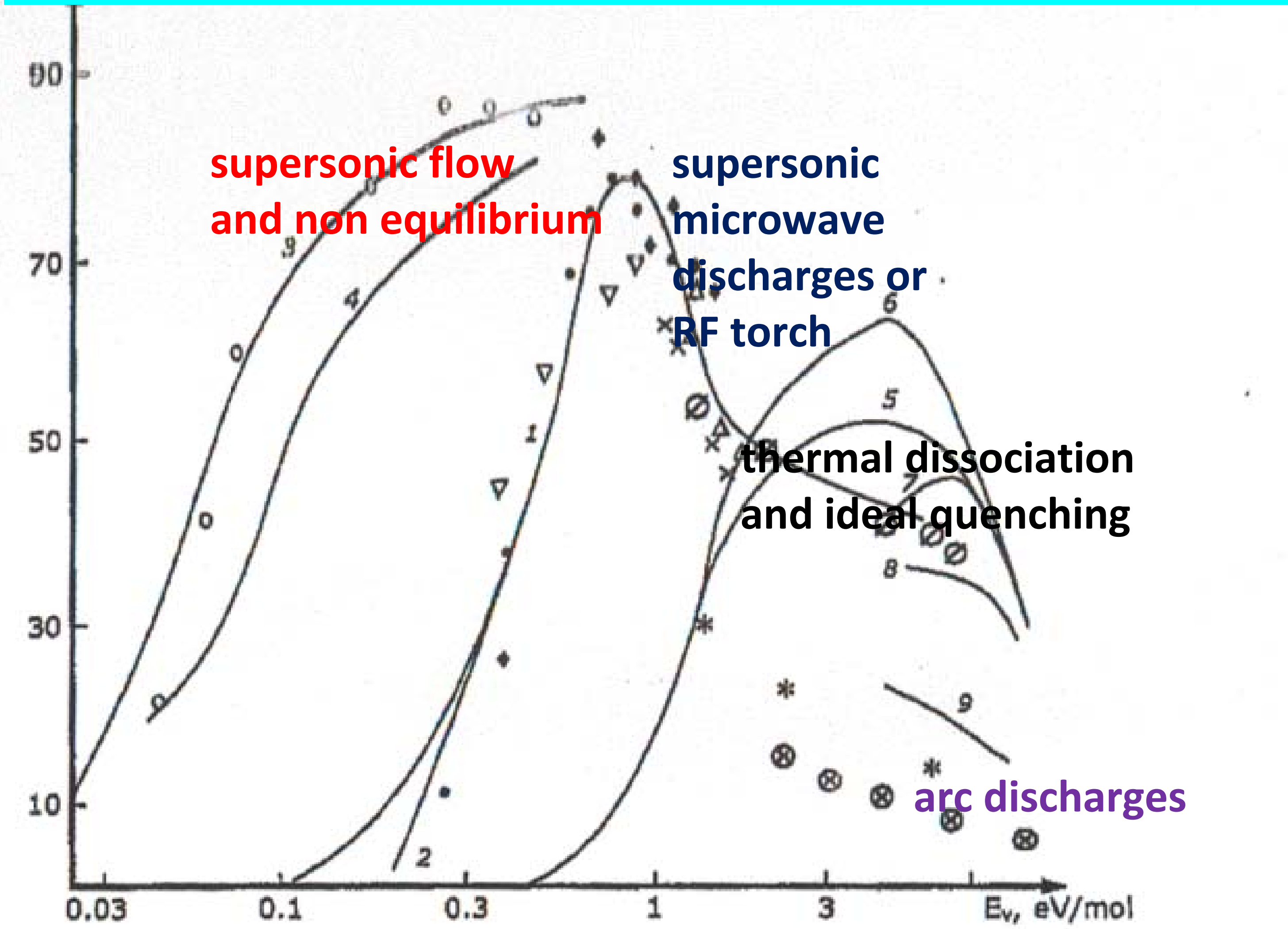


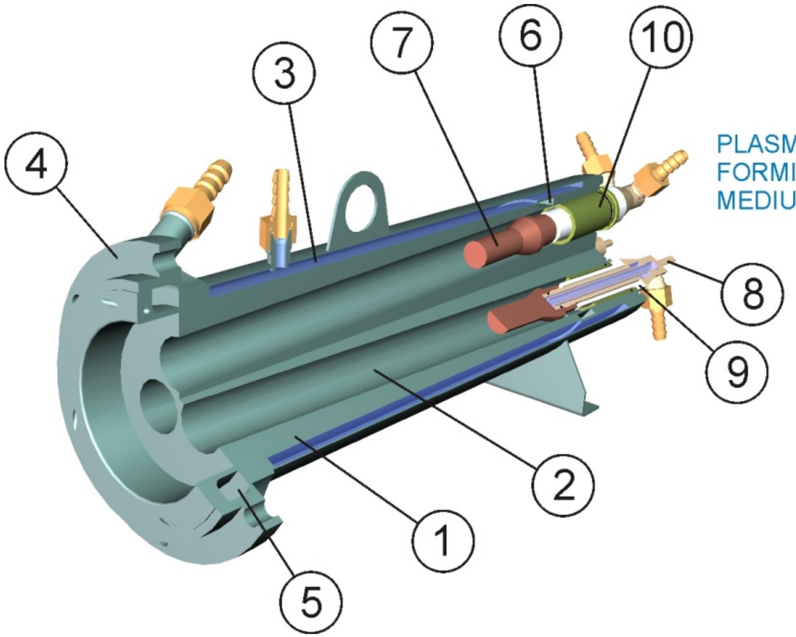
Figure 5–2. Energy efficiency of CO_2 dissociation as a function of specific energy input. (1, 2), non-equilibrium calculations in one- and two-approximations; non-equilibrium calculations for supersonic flows: (3) M = 5; (4) M = 3.5; calculations of thermal dissociation with (5) ideal and (6) super-ideal quenching; (7) thermal dissociation with quenching rates 10^9 K/s, (8) 10^8 K/s, (9) 10^7 K/s. Different experiments in microwave discharges: o, ♦, Δ, ×. Experiments in supersonic microwave discharges: •. Experiments in different RF-CCP discharges: o, ∇. Experiments in RF-ICP discharges: ∅. Experiments in different arc discharges: ⊗, *.

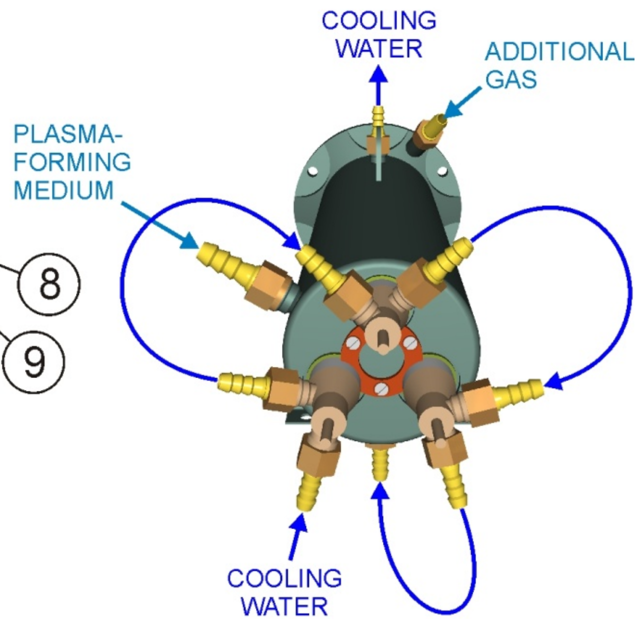
Results from the team of PH. RUTBERG RSA

- Plasmas processes for coal gaseification with carbone dioxide as plasma gas

- Russian Academy Lab of electrotechnic and plasmas
- Polytechnical State university St Petersbourg

THREE-PHASE PLASMA TORCHES

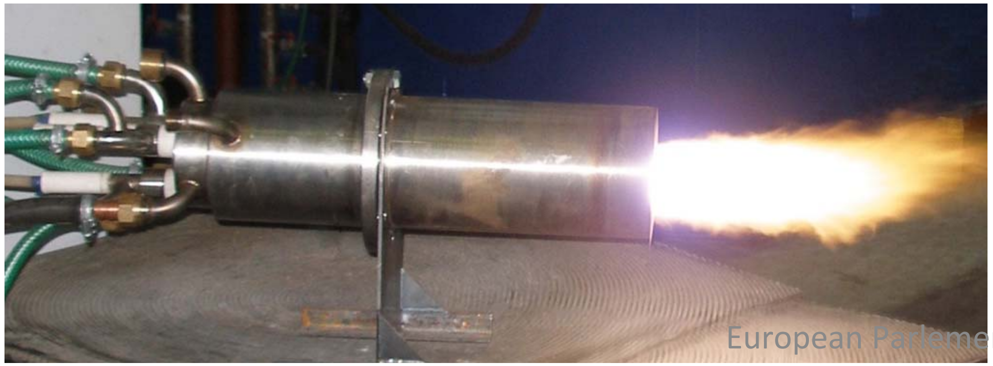


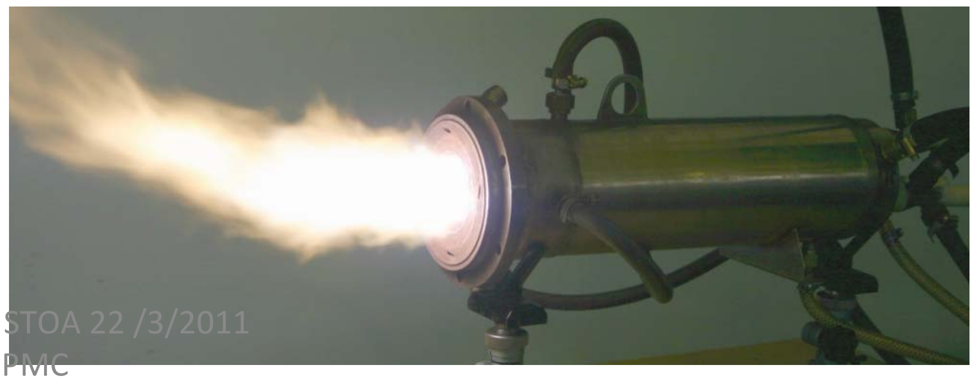


1- CASE
2- DISCHARGE CHANEL
3- COOLING JACKET
4- FLANGE
5- ADDITIONAL AIR DISTRIBUTOR
6- WORKING MEDIUM DISTRIBUTOR
7- ELECTRODE
8- ELECTRODE HOLDER
9- CERAMIC INSULATOR
10- SEALING BUSHING

PLASMA-FORMING MEDIUM: AIR POWER: up to 40 kW VOLTAGE 6-10 kV

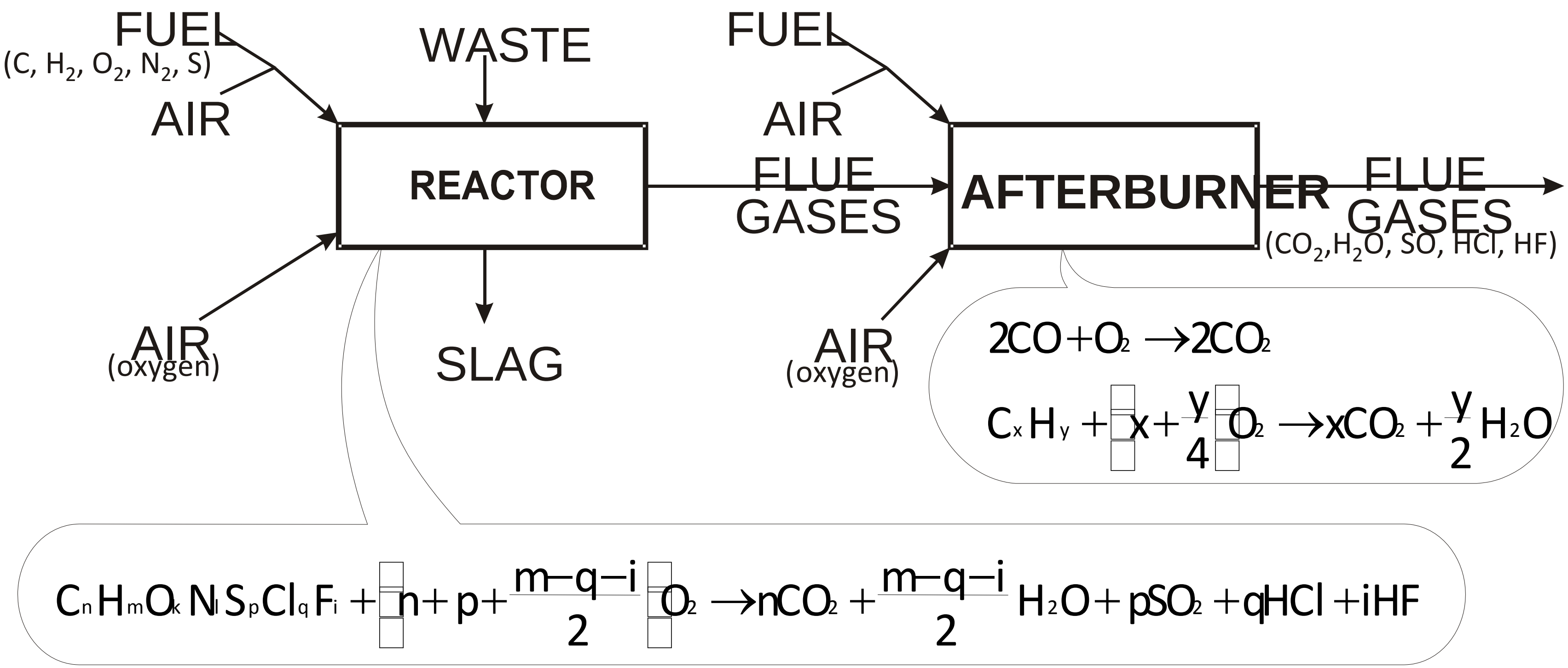
CO_2 POWER: up to 50 kW





ADVANTAGE OF THE PLASMA PROCESS

TRADITIONAL COMBUSTION

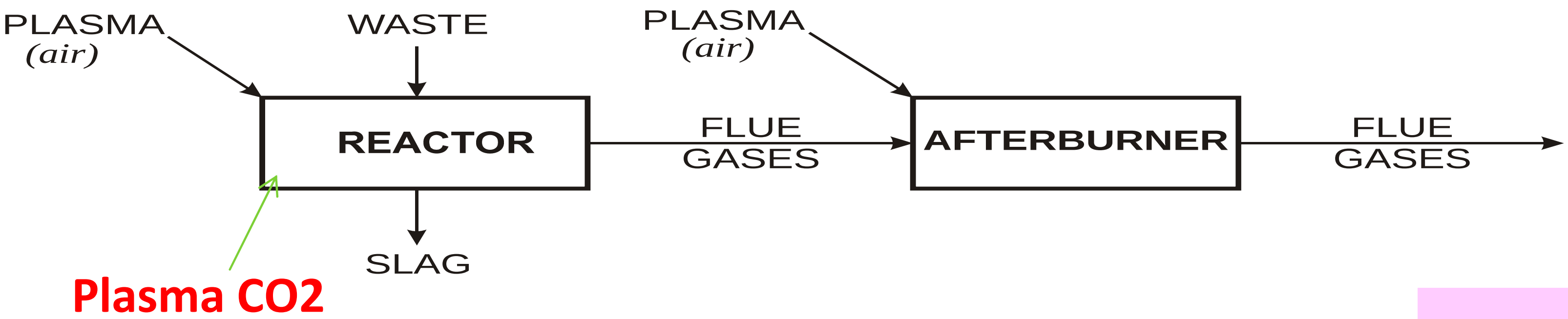


$$2CO + O_2 \rightarrow 2CO_2$$

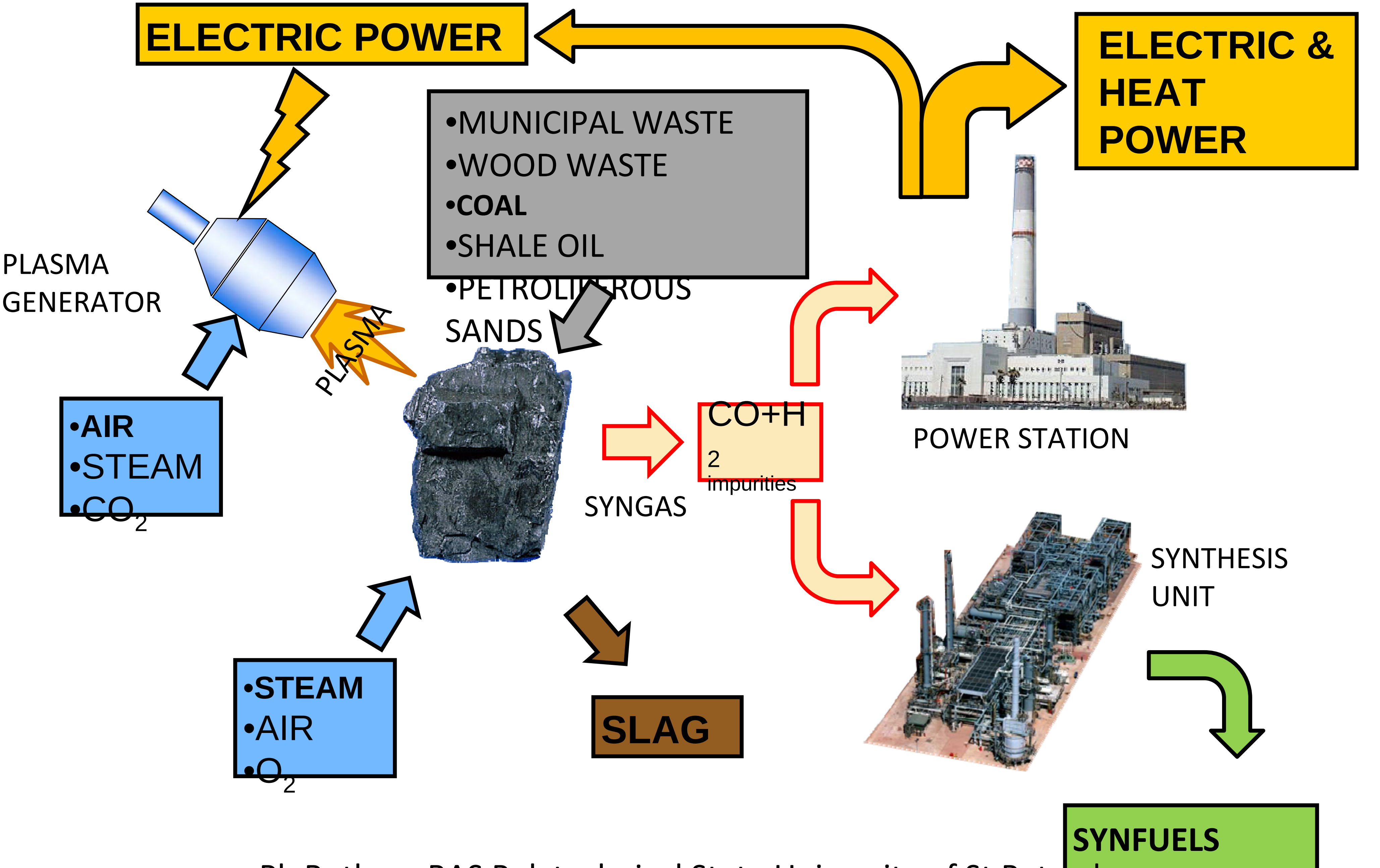
$$C_xH_y + \left(x + \frac{y}{4}\right) O_2 \rightarrow xCO_2 + \frac{y}{2} H_2O$$

$$C_nH_mO_kN_lS_pCl_qF_i + \left(n + p + \frac{m-q-i}{2}\right) O_2 \rightarrow nCO_2 + \frac{m-q-i}{2} H_2O + pSO_2 + qHCl + iHF$$

PLASMA COMBUSTION

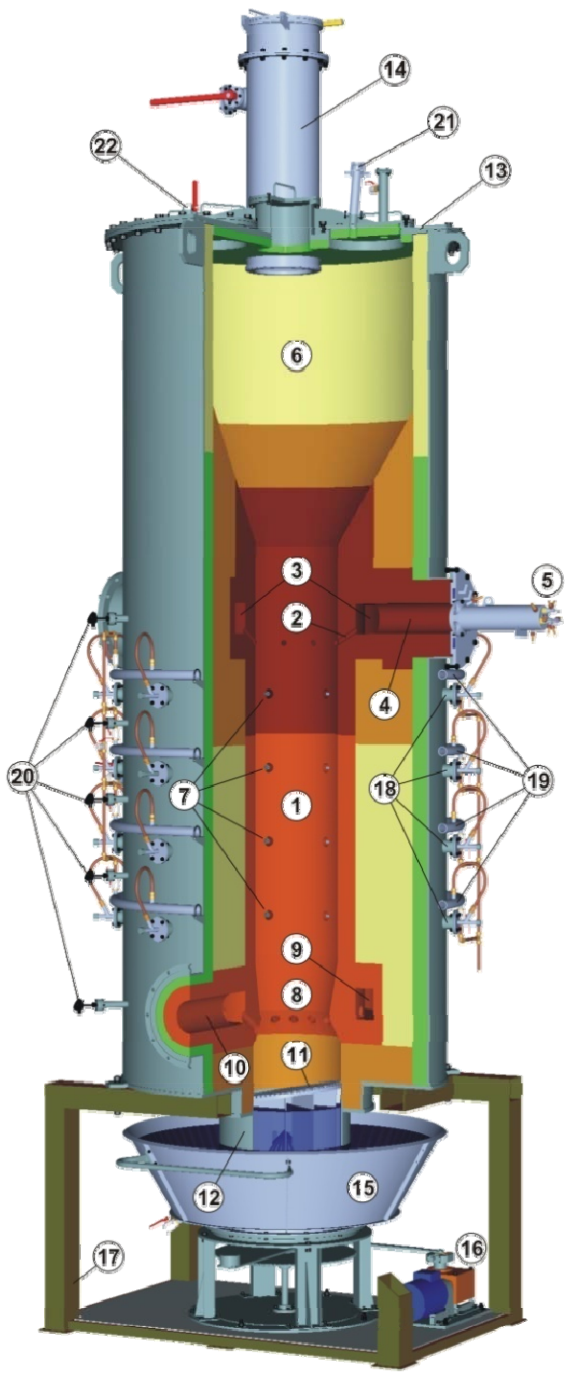


PLASMA GASIFICATION



Ph Rutberg RAS Polytechnical State University of St Petersbourg

SOLID WASTE PLASMA GASEIFICATION



PROTOTYPE OF 50-100 kg/h PRODUCTIVITY

1 - REACTOR SHAFT
2 - PLASMA BLASTING INPUT APERTURES
3 - RING ALLOCATOR OF PLASMA BLASTING
4 - PLASMA BLASTING DUCT
5 - PLASMA TORCH
6 - WASTE BUNKER
7 - BLOWING HOLES
8 - CONICAL PINCH
9 - PRODUCT-GAS RING COLLECTOR
10 - PRODUCT-GAS OUTPUT DUCT
11 - FIRE-GRATE
12 - WATERLOCK
13 - REACTOR COVER
14 - FEEDER
15 - SLAG COOLING BATH
16 - FIRE-GRATE ROTATION DRIVE
17 - SUPPORTING CONSTRUCTION
18 - SECONDARY BLOWING DUCTS
19 - SECONDARY BLOWING DISPENSER
20 - THERMOCOUPLES
21 - PEEP HOLE
22 - POKING HOLE BALL VALVE