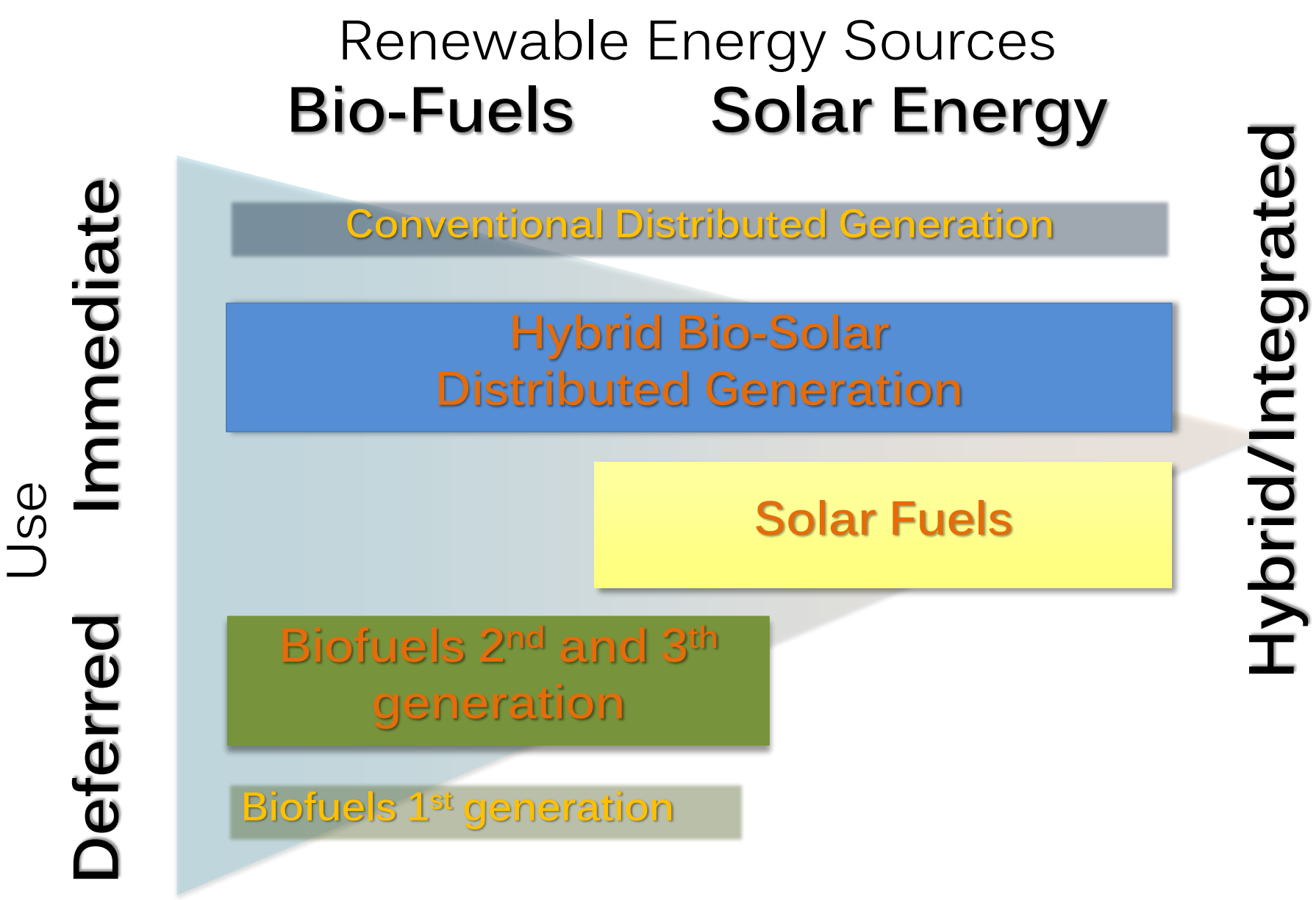
Processes and Technologies for Renewable Energy

THE REFERENCE CONTEXT



CHALLENGE

HORIZON 2020

LOW-COST AND LOW-CARBON ELECTRIC ENERGY AND FUELS

COMPETENCE, METHODOLOGIES AND FACILITIES

Competence

Pyrolysis
Gasification
Catalysis
Combustion Diagnostics
Fluidization
Combustion Kinetics
Combustion
Chemical and Thermal Plants
Numerical Simulation

Methodologies

CFD Simulation,
Sampling and Chemical Diagnostics,
Optical Diagnostics,
Modeling of Reactions Kinetics.

Facilities

High-temperature lab-scale plants,
Pilot scale prototypes,
HPC parallel Cluster,
Software,
GC,
Gas analyzers,
Analytical chemistry laboratory

Researchers

C. Allouis, P. Ammendola, R. Chirone, M. Commodo, M. de Joannon, I. Di Somma, L. Lisi, F. S. Marra, F. Miccio, P. Minutolo, R. Ragucci, G. Ruoppolo, P. Sabia, R. Solimene, M. Urciuolo

LINES OF ACTION

1 – BIOFUELS

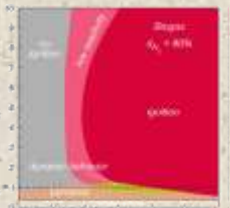
- COMBUSTION AND GASIFICATION OF BIOFUELS
- MICROGENERATION AND COGENERATION SYSTEMS

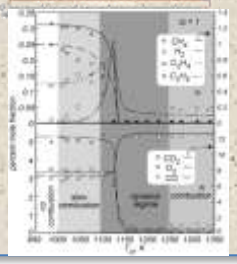
2 – SOLAR ENERGY

- CONCENTRATING SOLAR POWER (CSP)
- SOLAR FUELS

BioFuels Activity Line

Combustion and Gasification of Bio-Fuels





COMBUSTION AND GASIFICATION OF BIOMASS IN PILOT-SCALE BUBBLING FLUIDIZED BED REACTORS

Basic research: mixing and segregation of fuel particles inside the bed and of volatile matter in the splash zone

Applied research: optimization of thermal conversion process in terms of solid and gaseous emissions with different types of biomass and bed materials

PRODUCTION OF SYNGAS BY PARTIAL OXIDATION OF BIOGAS IN DILUTE CONDITIONS

Production of syngas from biogas (biomass and waste) for the synthesis of liquid fuels to be used in the fields of transport and propulsion, by means of Gas-To-Liquid (GTL) conversion processes of gaseous fuels.

Optimization of the syngas production process with appropriate CO/H_2 ratio by means of partial oxidation of biogas in MILD conditions.

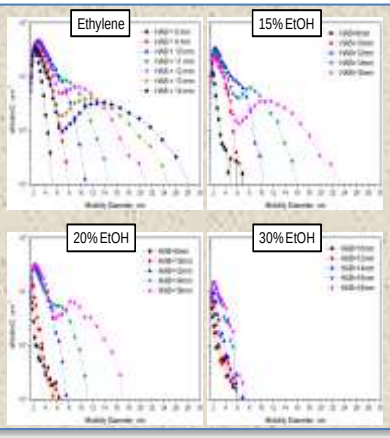
DEVELOPMENT AND USE OF REACTION KINETICS OF GASEOUS AND LIQUID BIO-FUELS

Characterization of reaction kinetics of gaseous and liquid bio-fuels, under standard conditions and dilute conditions, using both numerical and experimental approaches.

Detailed kinetic analysis: Parametric Continuation, Stream of Reactions, Rate of Production, Sensitivity Analysis. Design and optimization of combustion chambers for efficiency and environmental impact.

BioFuels Activity line

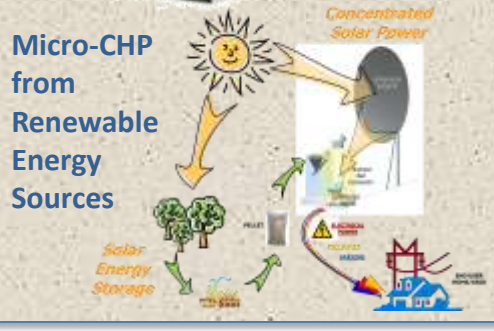
Bio-fuels combustion and gasification



CHARACTERIZATION OF MICRONIC AND SUBMICRONIC SOLID EMISSIONS

Fingerprint of the combustion aerosol: chemical and physical characterization of carbonaceous solid particulate produced by bio-fuel combustion (oxyfuels).
Fields of interests:
1. - Atmospheric chemistry,
2. - Effects on human health,
3. - Particle reactivity (removal in DPF systems).

Systems for micro- and co-generation



MICRO-TURBINE COMBUSTION OF PURE LIQUID BIO-FUELS AND/OR LIQUID BIO-FUELS AND HYDROCARBONS MIXTURES

Optimization of micro-turbine (100kWth) combustion of hydrocarbons/liquid bio-fuels mixtures. Study on the effect of combustion parameters on gaseous and particulate emissions.

DISTRIBUTED COGENERATION FROM BIOMASS AND SOLAR ENERGY BY STIRLING OR RANKINE THERMODYNAMIC CYCLES

MEGARIS Project. Innovative micro-cogeneration system based on renewable sources: solar energy and biomass. Electric energy production by a Stirling engine coupled with a fluidized bed combustor fed with wood pellets or heated by CSP.

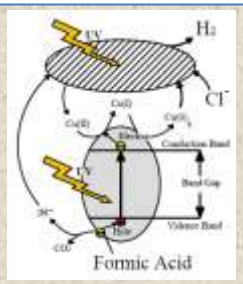
SolarEnergy Activity Line

Concentrating Solar Power (CSP)

DEVELOPMENT OF CONCENTRATED SOLAR PLANTS BASED ON FLUIDIZED BED CONFIGURATIONS

SOLTESS Project. Development of a cogeneration system from concentrated solar power able to collect solar radiation, to storage thermal energy and to exchange it for energy, steam or desalted water production. Development of hybrid plants by integration of solar energy with thermochemical conversion of biomass.

Solar fuels



TiO_2 activation: $TiO_2 + 2h\nu \rightarrow 2e^- + 2h^+$
CH_3OH oxidation: $CH_3OH + 2h^+ \rightarrow HCHO + 2H^+$
HCHO oxidation: $HCHO + H_2O + 2h^+ \rightarrow HCOOH + 2H^+$
HCOOH oxidation: $HCOOH + 2h^+ \rightarrow CO_2 + 2H^+$
H^+ ions reduction: $2H^+ + 2e^- \rightarrow H_2$

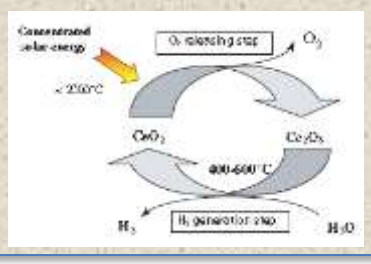


PHOTO-CATALYTIC REFORMING OF ORGANIC COMPUONDS FOR HYDROGEN PRODUCTION

GREEN CHEMISTRY. H_2 production by photo-catalytic reforming based on a photo-catalyst (semi-conductor solid, i.e. TiO_2) characterized by a low band gap (Eg) between the top of the valence band (VB) and the bottom of the conduction band (CB).

SYNGAS PRODUCTION BY THERMOCHEMICAL CYCLES

Production of CO/H_2 mixtures by redox cycles of granular solids (metal oxides) carried out in a fluidized bed reactor directly irradiated by a concentrated solar source simulated by an array of Xe lamps.

RELEVANT PARTNERSHIPS/PROJECTS

With academy

- Partners:
  - Università di Napoli Federico II
  - Università degli Studi del Sannio
  - Seconda Università di Napoli
  - EERA Alliance on CSP

- Funded Projects
  - MAE Italia-Israele
  - FP7 STAGE-STE

With companies

- Partners:
  - Magaldi
  - Aerosoft

- Funded Projects
  - SOLTESS (PON Project)
  - MEGARIS (Italian Ministry for Environment)

PERSPECTIVES

Medium and long term research issues

- Growing energy demand from renewable sources
- Greenhouse emissions abatement
- Global (Bio and Solar Energy) and local (distributed energy generation and cogeneration) energy self-sufficiency

Public funding

- Horizon2020 calls
- Italian Ministry MiSE calls
- Italian Ministry for Environment calls
- Local and Regional development calls
- Education calls

Private funding

- Emerging market penetration of innovative products (prototype development)
- Energy self-sufficiency of manufacturing industry
- Conversion processes of energy sources (BioRefinery)