Smart Energy Carriers for Smart Energy Technologies: Potential for EU-EaP Co-operation

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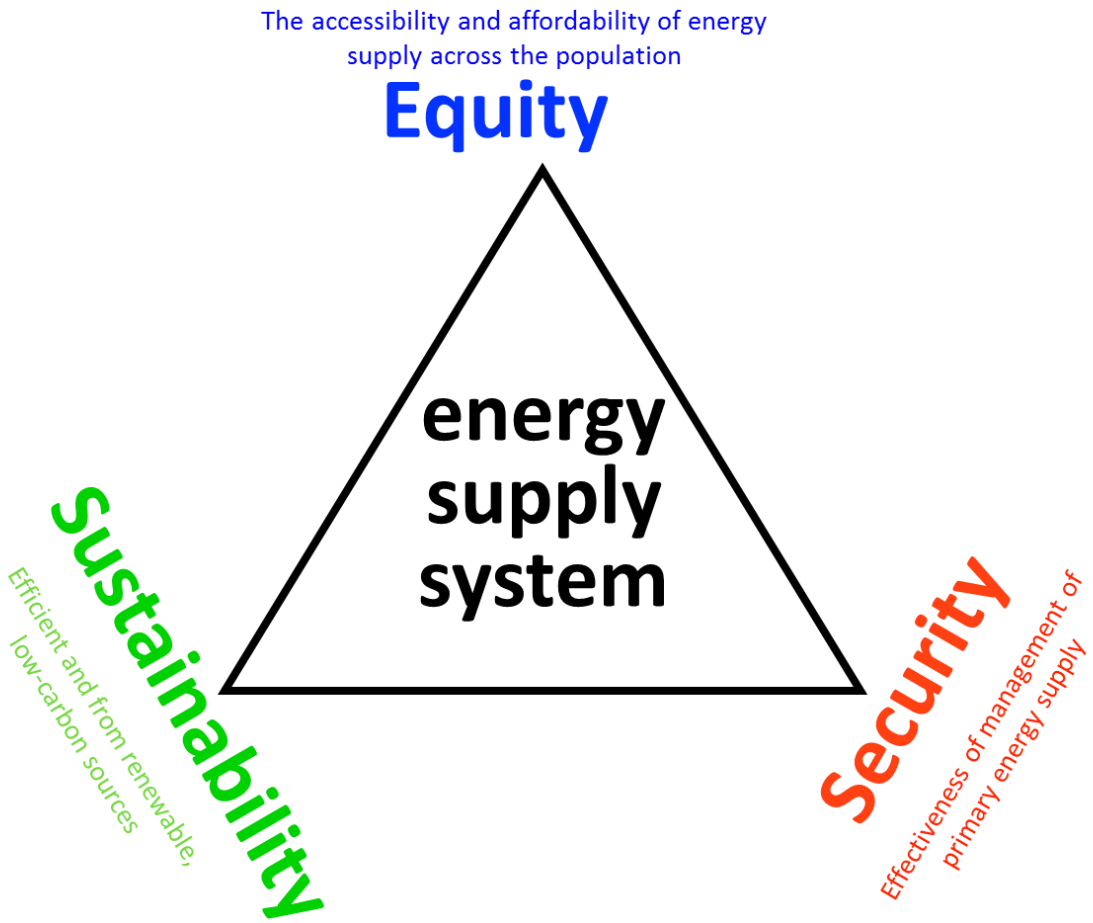
Setting the scene …

- Common goals/barriers shared by EU – EaP countries in energy policy
- Safe, secure and environmentally-friendly energy supply
- Sustainable combustion of conventional and alternative (renewable) fuels

- Challenge: Fuel flexibility of energy conversion technologies, minimization of Greenhouse Gas (GHG) emissions and adjustment of distributed energy production.

- Approach: Technological development through Research and Innovation

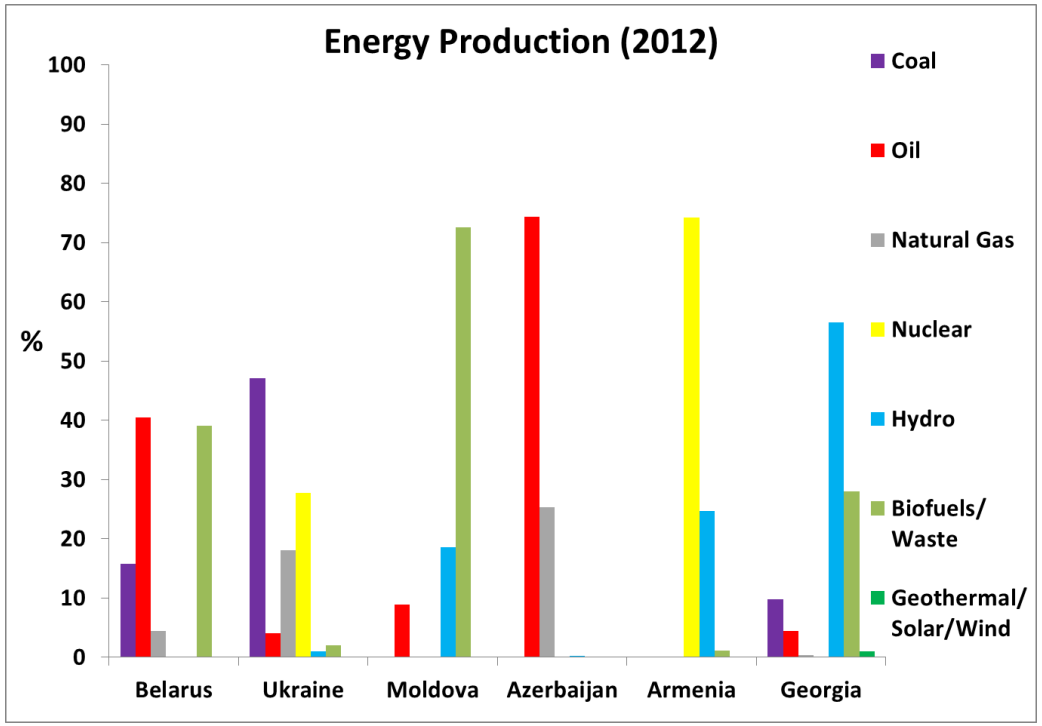
The Energy Trilemma

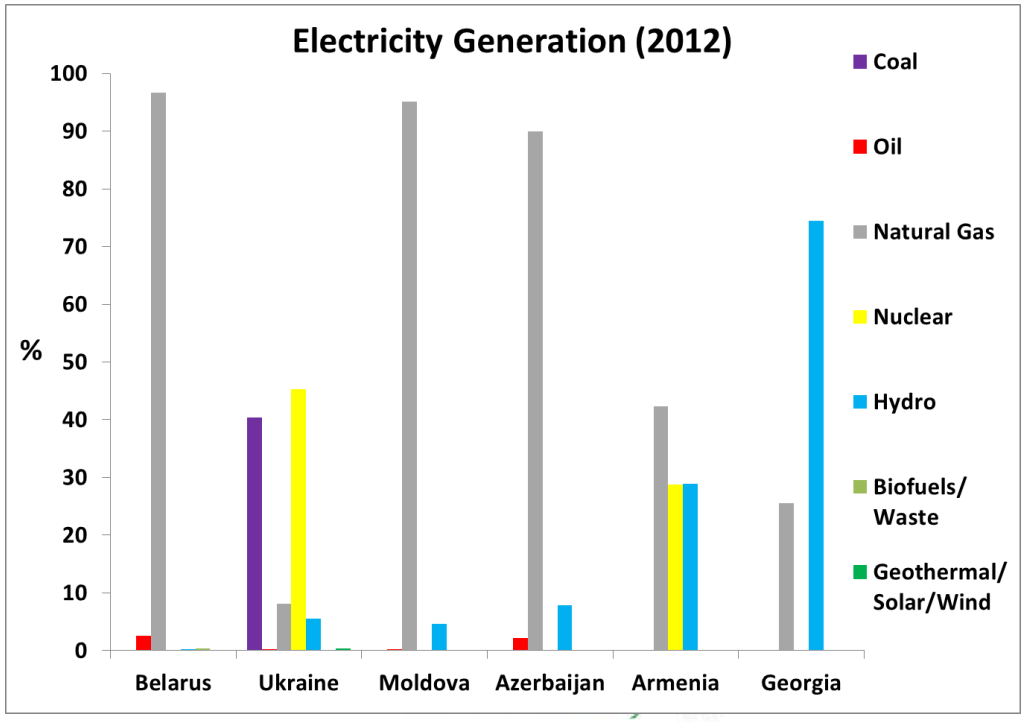


- A new energy production and distribution system based on smart grid concepts and utilizing Smart Energy Carriers (SEC).
- SECs are conventional and novel energetic molecules from conventional or alternative (re)sources selected on the basis of their best-available production and/or utilization technologies.
- SECs are strong candidates as possible solutions for energy storage, transfer and transformation form renewable (local) sources (wind, solar, biomass, waste).

The EaP Energy Map

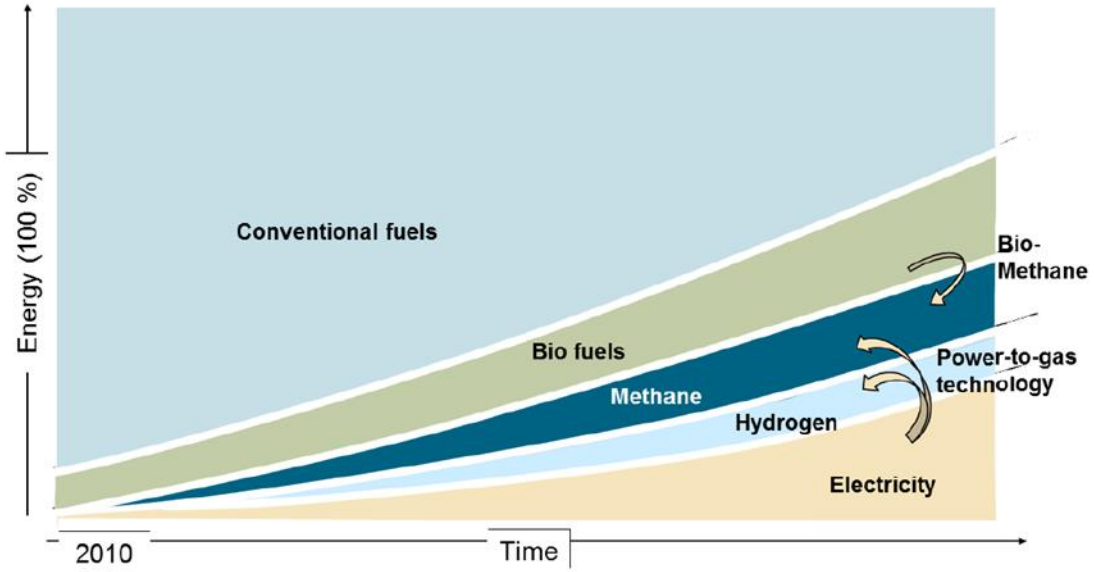
- With the exception of Azerbaijan, all EaP countries are to a certain extent dependent on the import of external energy sources (gas and oil).
- The share of renewables in both total primary energy sources and electricity production is extremely high in Georgia due to hydropower, while it is moderate in the other EaP countries.
- The share of agricultural sector is high in most EaP countries.





Smart Energy Options for the 21st century

- Alternative, decarbonized fuels for 60% CO_2 reduction by 2050.
- Higher process efficiency leading to clean environment and resource protection.



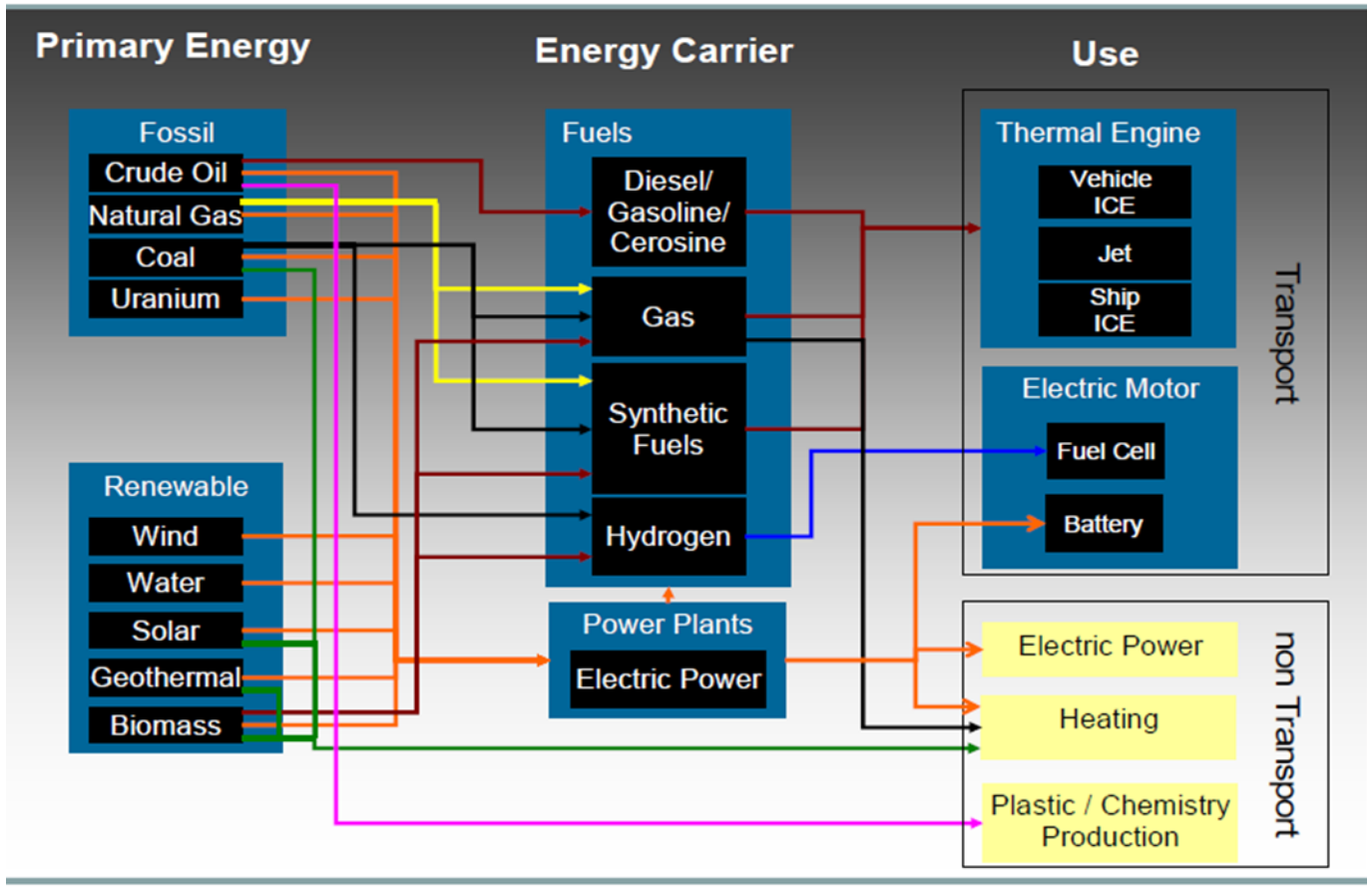
Challenges

- Parallel optimization of **energy carrier production** pathways and **power/propulsion technology**.
- High quality **residual-derived biofuels** and **power-to-fuel** options.
- Advanced combustion systems optimized for harmonized **fuel qualities**.
- Harmonized Europe-wide **infrastructures**.

Energy Roadmap 2050, COM(2011) 885

European Roadmap, Future Light-duty Powertrain Technologies and Fuels, ERTRAC 2011

Smart Fuels for the 21st Century



CO_2 Mitigation/Utilization

- Power-to-fuel
- Solar fuels

Residual-derived biofuels

- Gaseous (bio-) fuels: CNG, LNG, (Biogas, Biomethane)
- On the edge of sustainability: Methanol & DME
- Biofuels (First-, second- and third-generation biofuels)
- Synthetic liquid fuels: xTL
- Waste-to-fuel

Smart Fuels for the 21st century

	Advanced Biofuels			Conventional biofuels
	Basic & applied R&D	Demonstration	Early commercial	Commercial
Bioethanol		Cellulosic ethanol		Ethanol from sugar and starch crops
Diesel-type biofuels	Biodiesel from microalgae, Sugar-based hydrocarbons	BTL diesel	HVO	Biodiesel (transesterification)
Other fuels and additives	Novel fuels (e.g. furanics)	Biobutanol, DME, Pyrolysis-based fuels	Methanol	
Biomethane		Bio-synthetic gas		Biogas (anaerobic digestion)
Hydrogen	Novel routes	Gasification with reforming	Biogas reforming	

Solar Fuels

CardioSol

European Research Council
Advanced Grant
erc

H_2O

CO_2

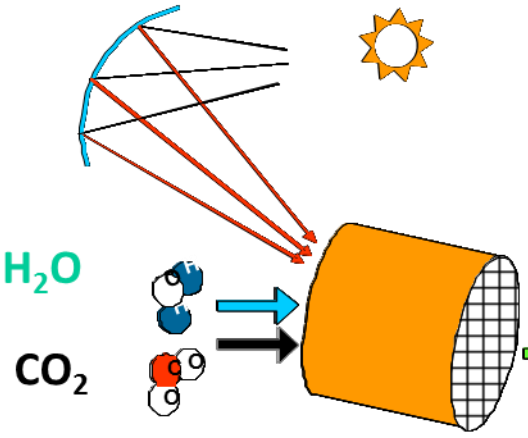
H_2

Electric Energy

CH_4, C_xH_y
Fuels & Chemicals

Waste Heat for Solar
Desalination H_2O

HYDROSOL plant



Solar Fuel Reactor

H_2O

CO_2

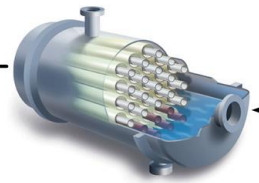
H_2

CO

Solar fuels

CO_2 for Utilization

Off-gases



Flue gases

MEMBRANE MODULE

CO_2

clean exhaust

CO, HC
NOx, Soot

Multifunctional Emission Control Reactor

SMARTCATs

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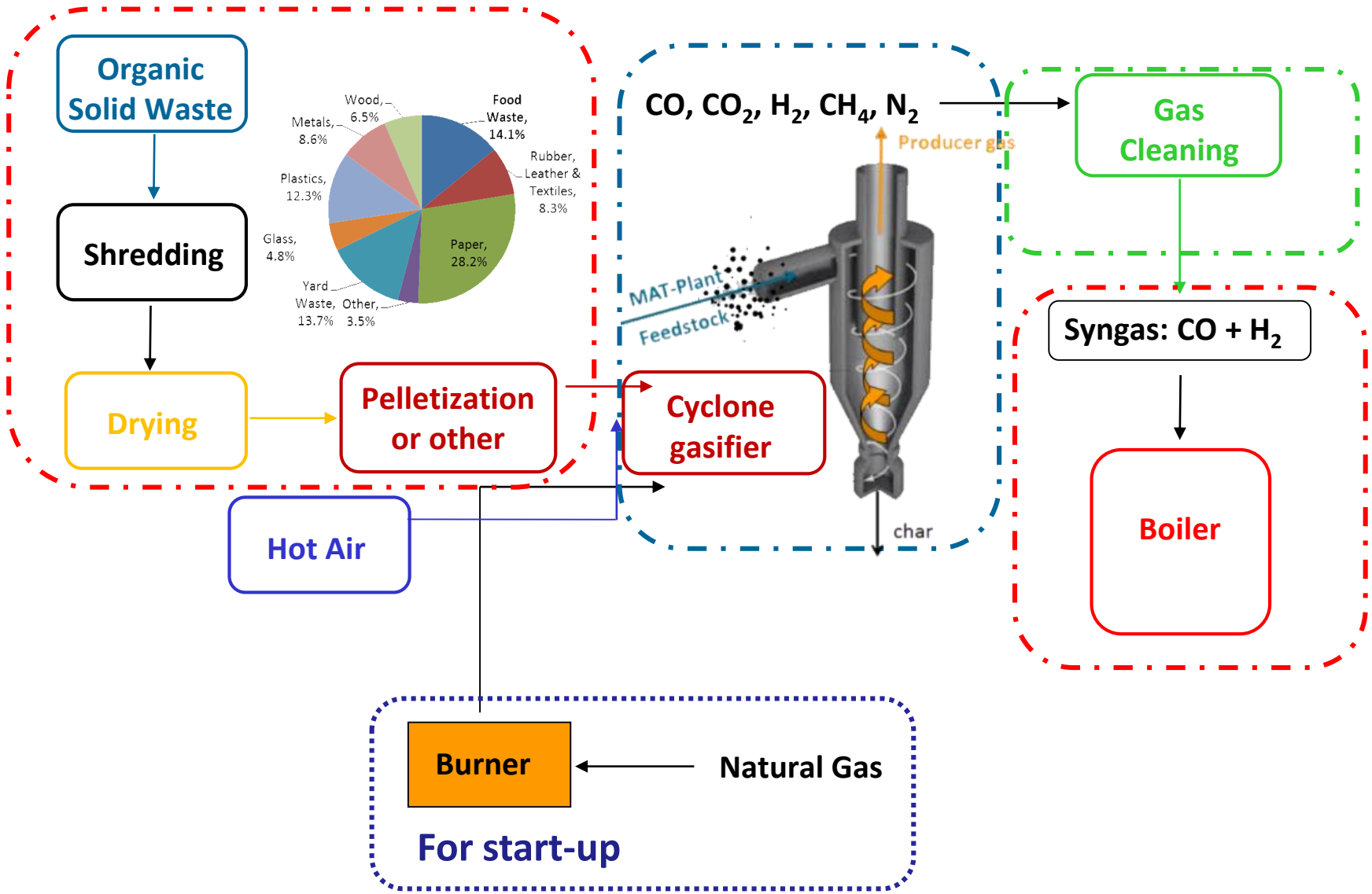
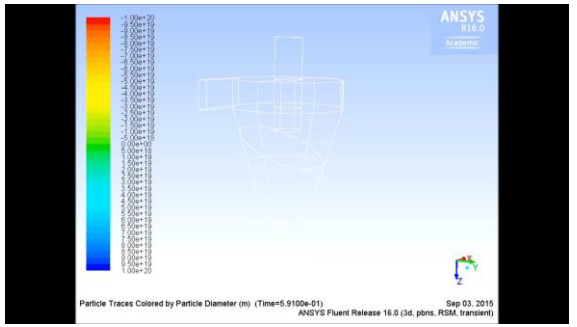
Waste-to-Fuels





CHORUS
The clean energy cluster

CM1404 SMARTCATs

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Solid Biofuels: Infrastructure – The uP-running H2020 Project

Motivation

- Agricultural wood prunings currently left on the field, burned in open fires or shredded for mulching
- EU28 potential: 28 Mt/y, capacity to put an extra 10% to the European solid biofuel market
- Social impacts in line with rural development strategy
- Continuation of FP7 EuroPruning project focusing mostly on technical aspects of prunings' logistics

Project team

- Coupling of 1 technical + 1 agrarian partner in four countries with high pruning potential: Spain, Italy, Greece, **Ukraine**
- Agrarian partners in 3 outreach countries: France, Portugal, Croatia

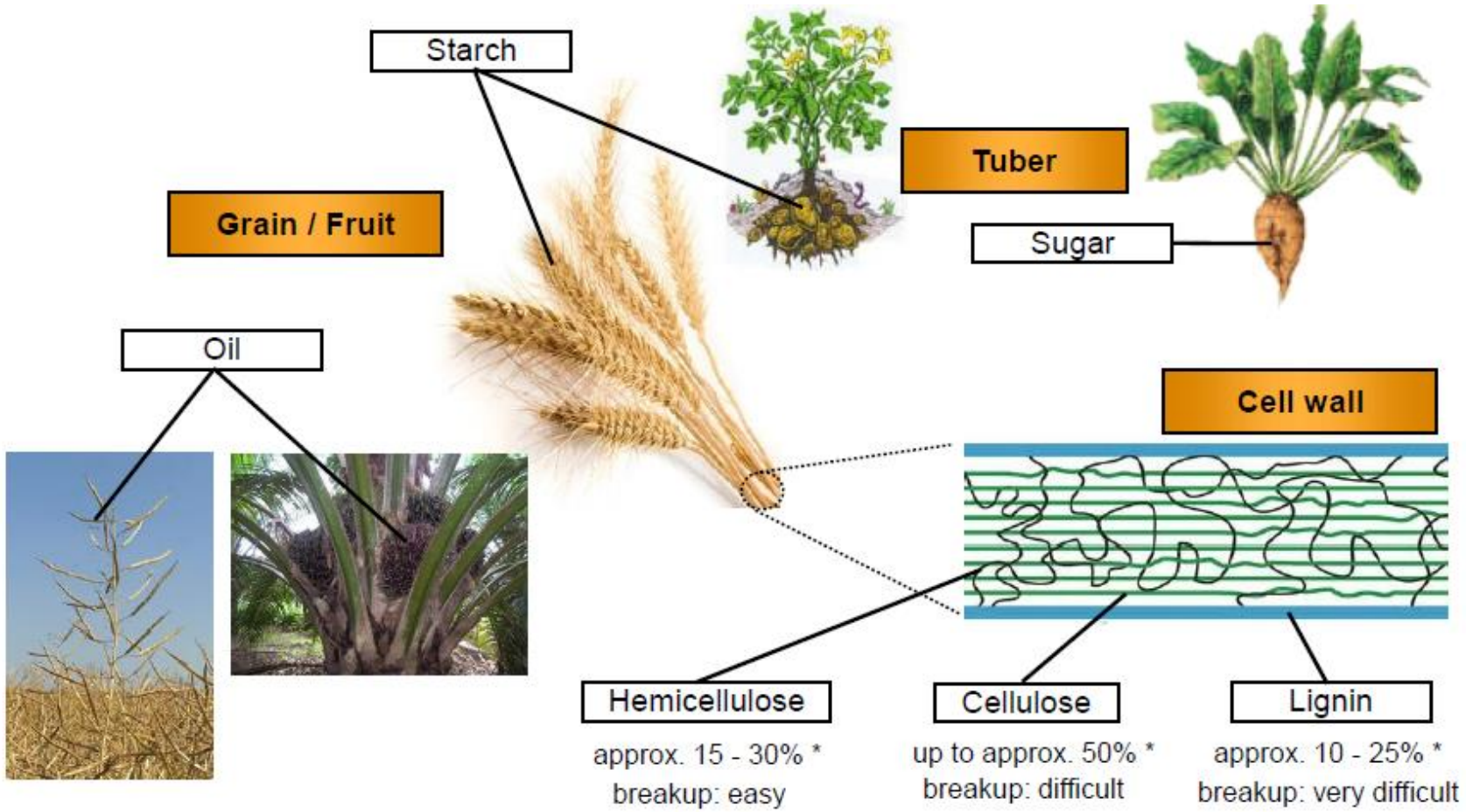
Project aims

- Overcoming unwillingness / scepticism / ignorance of farmers by demonstrating potential and real cases of utilization
- Supporting the start-up of new sustainable chains at local and regional scales
- Building capacities of agrarian associations to provide consultancy to farmers for future projects
- Engaging key stakeholders (final consumers, technology owners, machinery builders) and authorities

Project data

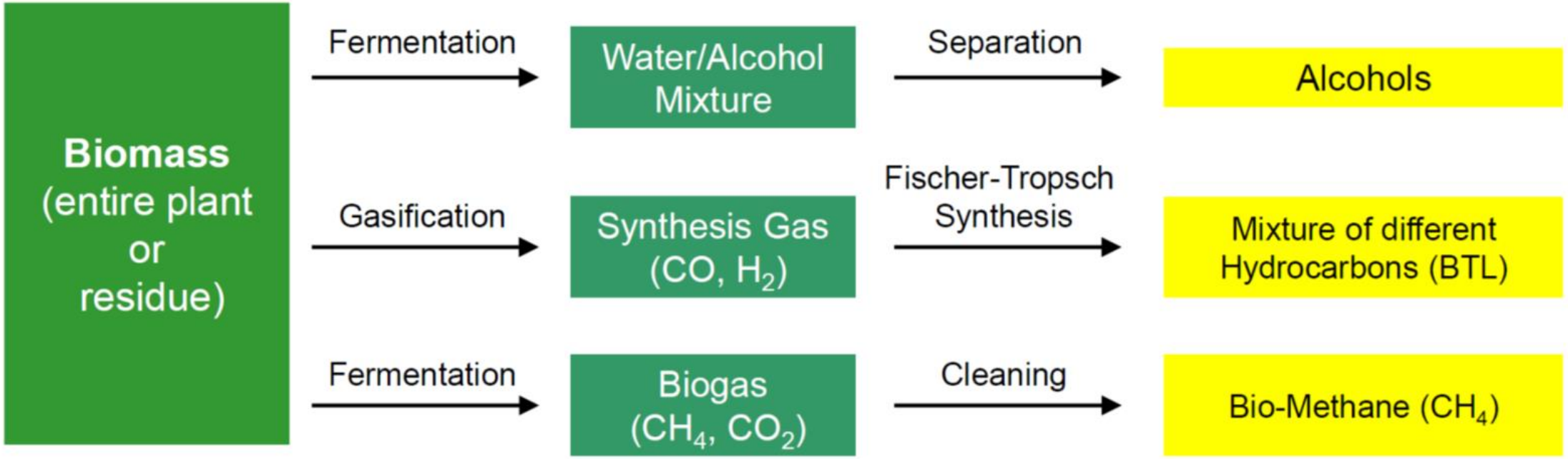
- Project Coordinator: CIRCE (Spain)
- Duration: January 2015 – June 2019
- Budget: 1,992,916 €
- Funded by the Horizon2020 Programme

Liquid Fuels: 2nd & 3rd Generation Biofuels



FEV (2012)

Liquid Fuels: 2nd & 3rd Generation Biofuels



Liquid Fuels: 2nd & 3rd Generation Biofuels

Raw material

- Non arable crops (ligno)
- Agricultural & forestry waste
- Municipal waste
- Microalgae

Products

- Synthetic fuels
- Bioethanol, biomethanol, ETBE, MTBE
- Paraffinic fuels (HVO)
- FAME
- Biogas

Technologies

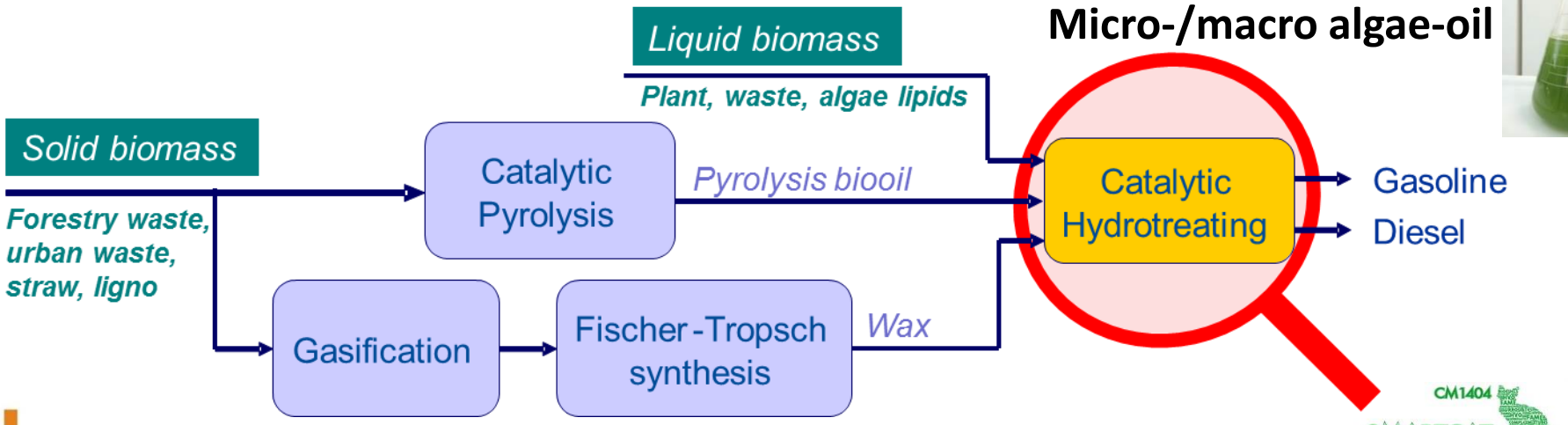
- BTL (Biomass-To-Liquid)
- Enzymatic conversion (hydrolysis, fermentation)
- Catalytic Hydroprocessing
- Pyrolysis
- Transesterification

Technology developed by HydPro group @ CPERI, CERTH

Waste cooking oil

Pyrolysis bio-oil

Micro-/macro algae-oil



More info:

- http://hydpro.cperi.certh.gr
- www.biofuels2g.gr
- www.sustaindiesel.gr

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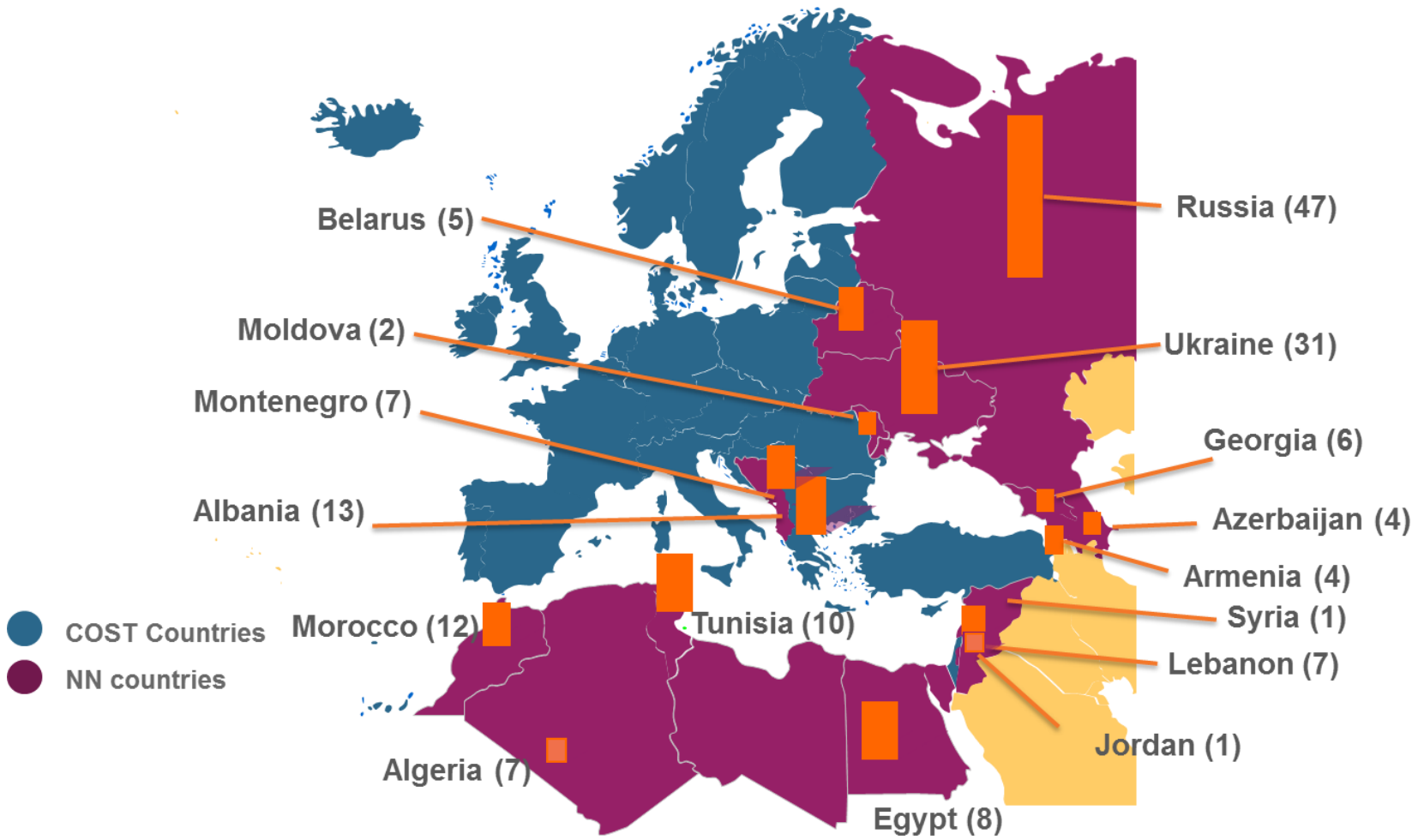
Introduction

Founded in Brussels in 1971 by Ministerial Conference of 19 European states, COST is the first and widest European intergovernmental framework for transnational Cooperation in Science and Technology

For more than 40 years COST has supported networking of research activities across all its 36 Member countries and beyond

COST is open to all disciplines and all novel and ground-breaking S&T ideas, and to all categories of partners where mutual benefit is real

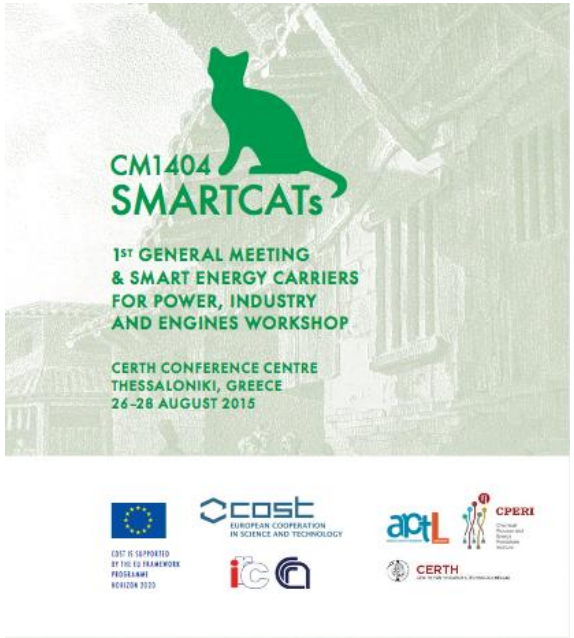
Near-Neighbour Countries (NNC)



- COST allows the participation of researchers, engineers and scholars from European and non-European countries, other than Members or Cooperating State of COST, in COST Actions and other activities with the aim to foster the dialogue and cooperation with key actors in the European and global science and technology scene on the base of ascertained mutual benefit (incl. all EaP countries).
- Researchers affiliated to institutions from NNC can participate in any activities of a COST Action (incl. STSM).
- Training schools may be allowed in NNC on a case by case basis if relevant to the topic of the Action and proved that there is an added value to the COST Action.

The SMARTCATs COST Action

CHEMISTRY OF SMART ENERGY CARRIERS AND TECHNOLOGIES: A EUROPEAN COST NETWORK



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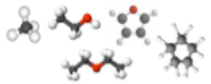
The SMARTCATs COST Action

The SMARTCATs COST Action aims to set-up a Europe-wide network of leading academic and research institutions and key industries to promote the use of smart energy carriers on a large scale in order to increase fuel flexibility and carbon efficiency of energy production and to support distributed energy generation strategies.

Smart Energy Carriers (SECs)

novel AND conventional energetic molecules

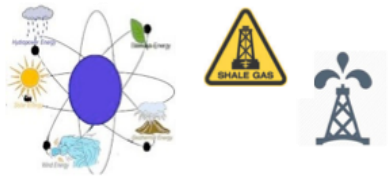


and many others ....

increasing in number and typology

deriving from

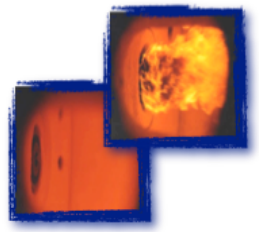
alternative or conventional (re)sources



increasing in number and typology

advanced processes and technologies

H_2 enriched gas turbines



SECs features:

exploiting many and diverse sources

providing the most suitable energy mix for the end-use technology

energetically and CO_2 efficient on the basis of used technologies

WG1

Smart energy carriers gas phase chemistry: from experiments to kinetic models

WG2

Chemistry for control of by-products in smart energy carrier conversion

SMARTCATs

WG5

Integration of fundamental knowledge towards technology application for smart energy carriers exploitation

WG3

Chemical and optical advanced diagnostics for smart energy carriers conversion monitoring

WG4

Standard definition for data collection and mining toward a virtual chemistry of smart carriers

The SMARTCATs COST Action

NETWORKING TOOLS

- **Workshops, meetings, conferences**

  Meetings are organised in any COST country participating in the network. They can be of different types, such as Management Committee meetings, Working Group Meetings, Workshops and Conferences. They are open to the whole scientific community and provide visibility opportunities for the COST Action. COST contributes to the travel and subsistence costs of participating scientists, and to the organisation costs of the meeting (**1st SMARTCATs General Meeting, Thessaloniki, Greece, 8/2015, Workshop on Smart Energy Carriers for Power, Industry and Engines, Thessaloniki, Greece, 8/2015, 2nd General Meeting, Lisbon Portugal, 9/2016, Workshop on Smart Energy Carriers in SMEs, 2016**)

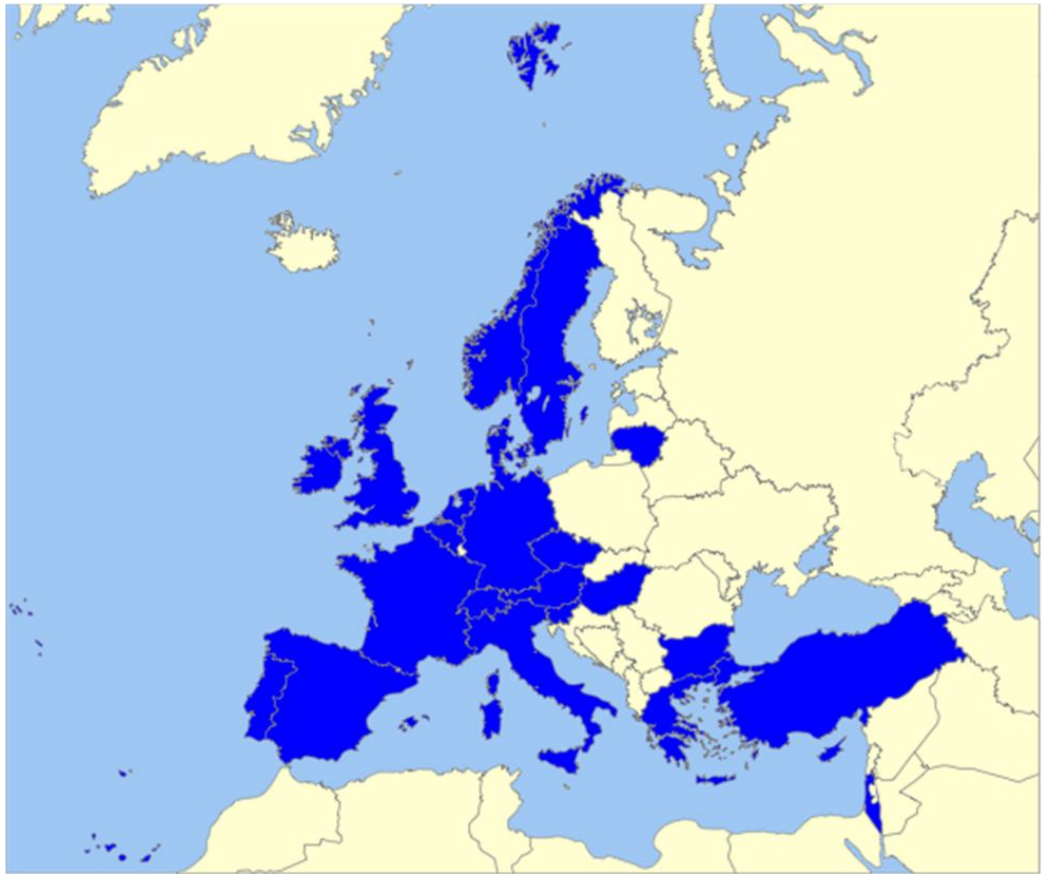
- **Training schools**

  Training Schools provide intensive training in emerging research topics within the laboratories and organisations involved in the COST Action. Participants are mainly, but not exclusively, young researchers involved in COST Actions. (**Training school on uncertainty analysis of SECs kinetic mechanisms, Budapest, Hungary, 6/2015**).

- **Short Terms Scientific Missions**

  Short-term scientific missions (STSM) are exchange visits between researchers involved in a COST Action, allowing scientists to visit an institution or laboratory in another COST country. They are aimed at fostering collaboration, sharing new techniques and infrastructure that may not be available in other participants' institutions or laboratories. STSM are intended especially for young researchers.

The SMARTCATs COST Action



23 Countries (Member States and Co-operating Countries)

+

Georgia (Near-Neighbour Country)

=

75 Participating Organizations

Energy Targets in H2020 WP 2016-17 Programme

- **Energy Efficiency**: High efficiency conversion devices represent elements of a higher efficiency portfolio
- **Renewable Energy**: Traditional RES (solar, wind, hydro) but also biogenous fuels (biogas, bio-syngas, bio-fuels) and new synthetic vectors (H_2, synthetic natural gas, etc)
- **Carbon capture, storage and utilization**: Mitigation of CO_2 emissions (related to efficient energy conversion devices and improved adoption of RES fuels) and CO_2 recovery and utilization
- **Smart grids**: Large topic, in which several technologies are included (energy storage, ICT intelligence of the grid, etc), among which the concept of distributed CHP plants has an important role.

Conclusions

- Address challenges and needs common in the EU-EaP nexus.
- Highly efficient low-carbon, fuel-flexible energy production technologies coupled with short- and medium-term emission containment adjusted to distributed energy production.
- Explore synergies/cooperation in Research and Innovation projects for technological development.
- Exploit EU financial /networking tools (Horizon 2020).