

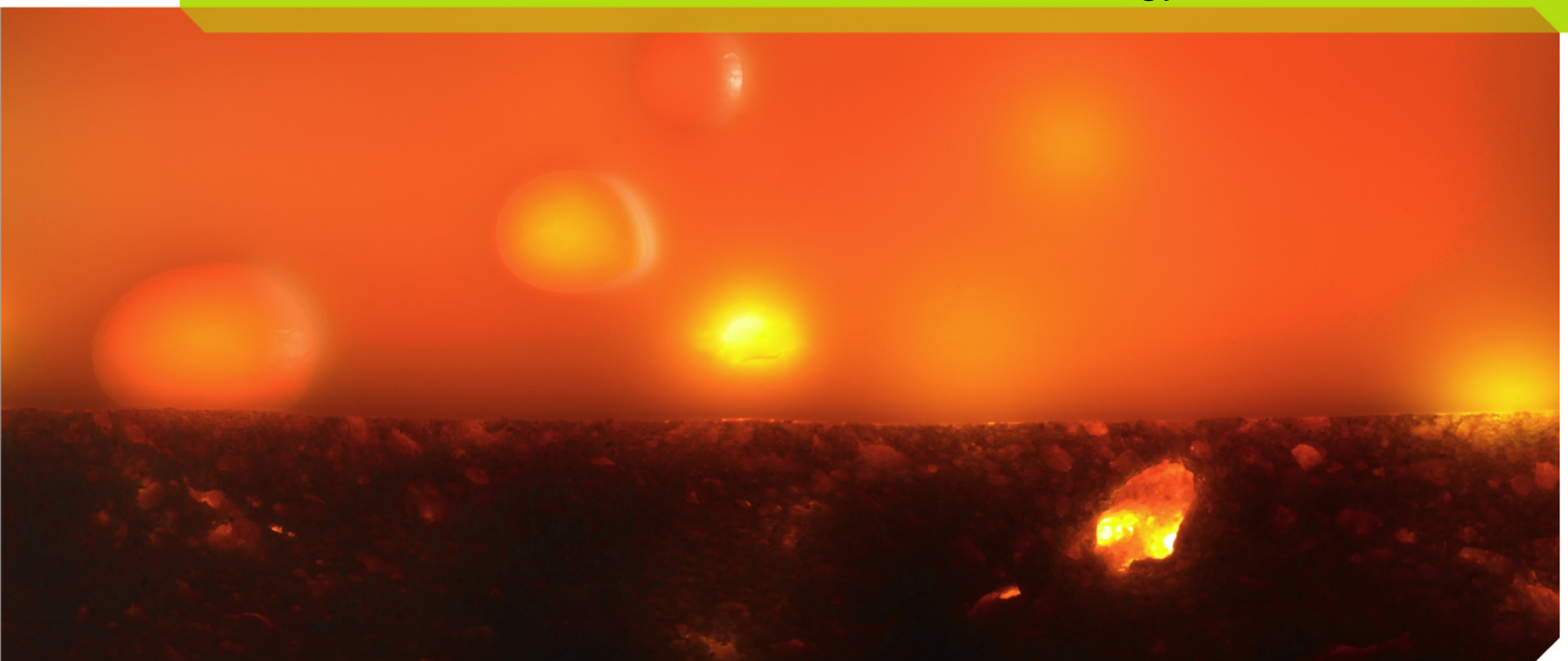


Schweizerische Eidgenossenschaft  
Confédération suisse  
Confederazione Svizzera  
Confederaziun svizra

Bundesamt für Energie BFE  
Office fédéral de l'énergie OFEN  
Ufficio federale dell'energia UFE  
Swiss Federal Office of Energy SFOE

# National Energy and Combustion Research Strategy in Switzerland

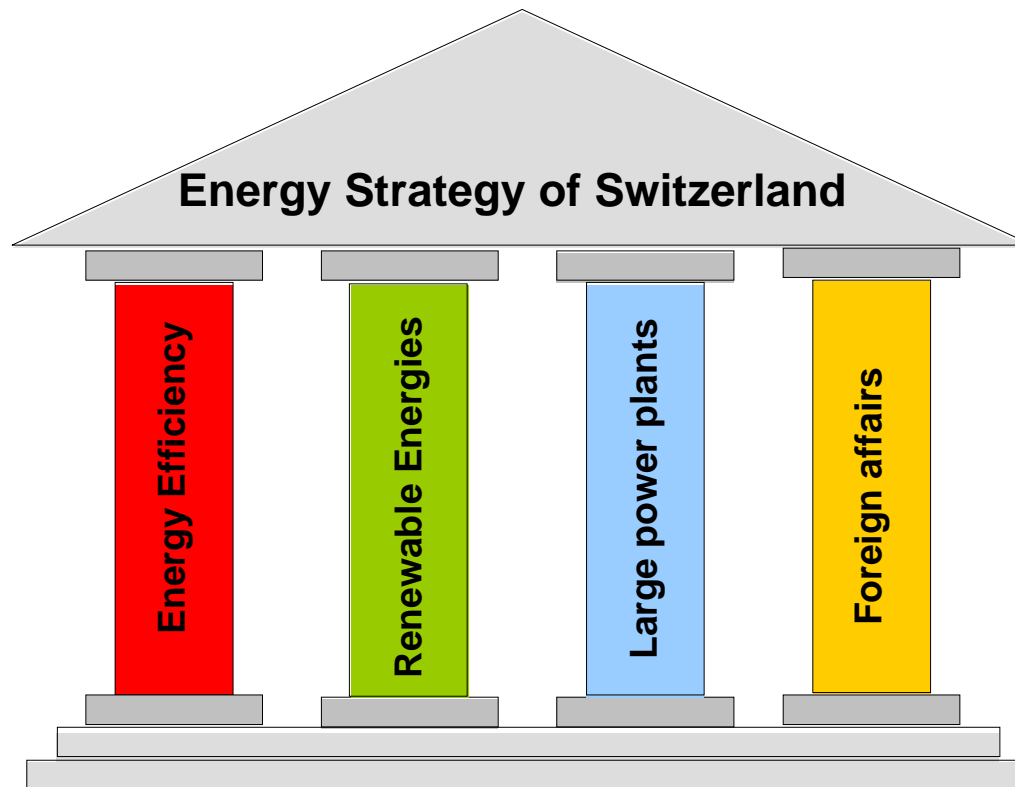
Swiss Federal Office of Energy





# Energy Strategy of Switzerland

---





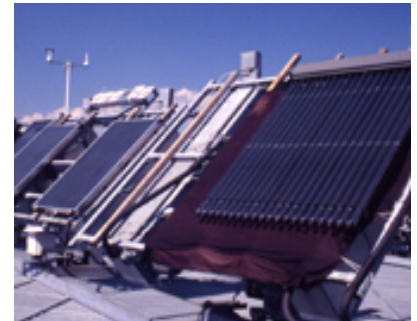
# Action plans and measures

---



## **Action plans and measures (February 2008):**

- 20% reduction of fossil energies until 2020
- 50% increase of renewable energies
- 5% increase of electric power consumption between 2010 and 2020 with a stabilisation and decrease afterwards

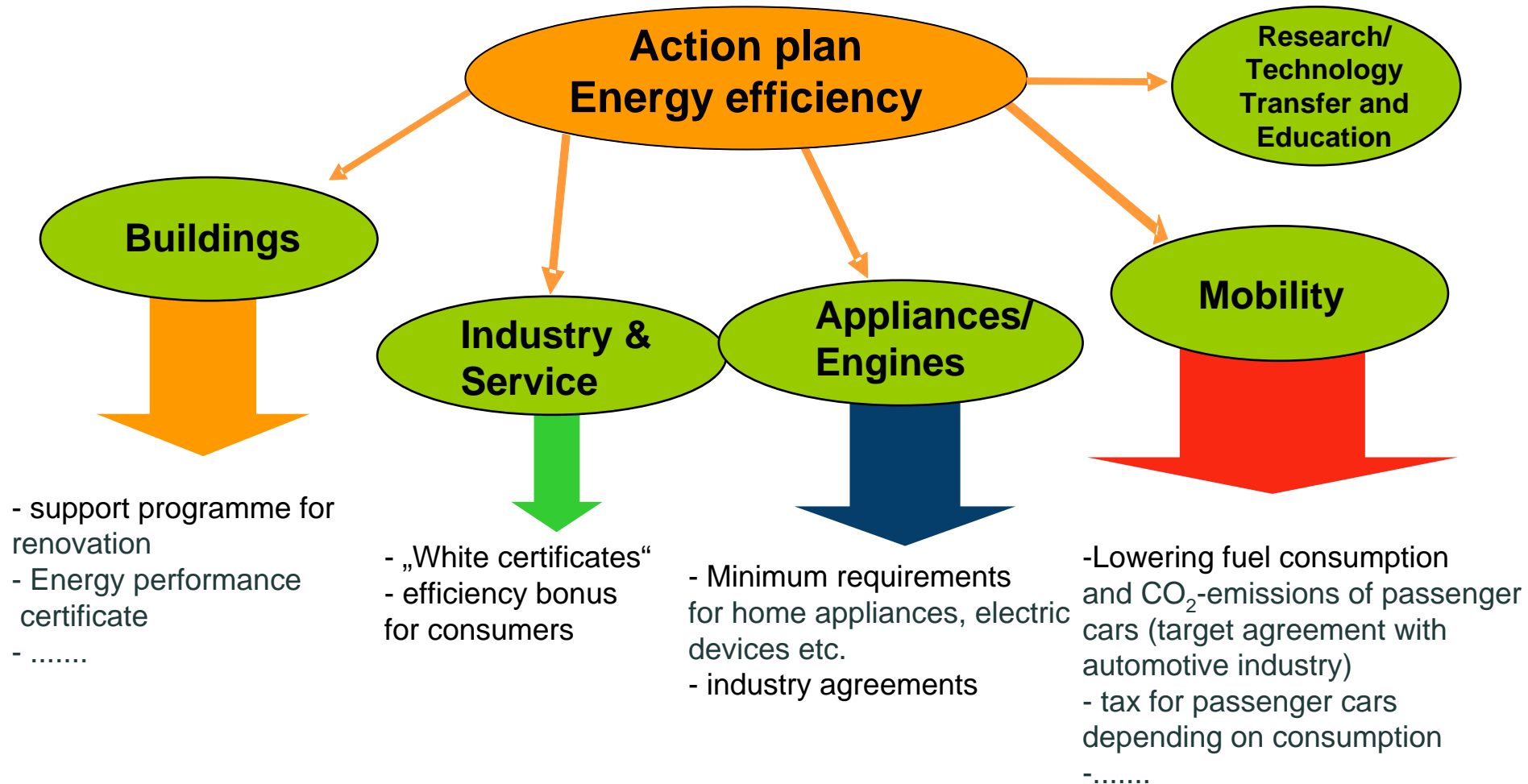




# Action plans and measures – Energy efficiency

## 15 measures

---

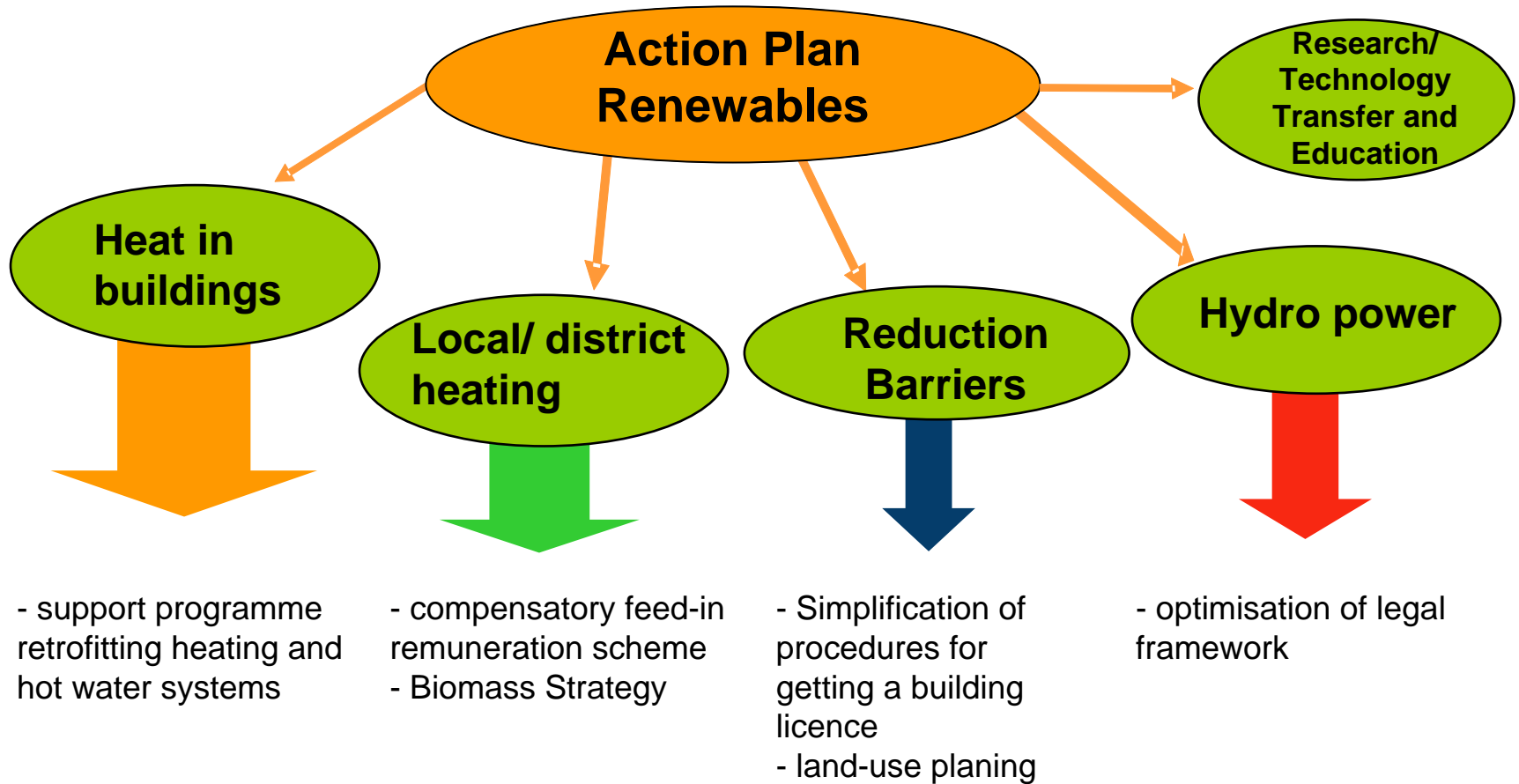




# Action plans and measures – Renewable Energy

## 7 measures

---







# Energy Research in Switzerland

## Concept of the Federal Council 2008 – 2011

---

### **Aim No.1**

**Renouncement of fossil fuels for the supply of heat in buildings**

### **Aim No.2**

**50% reduction of the energy consumption in buildings**

### **Aim No.3**

**Abatement of the averaged fuel consumption of vehicles to 3 l gasoline equivalent per 100 km**

### **Aim No. 4**

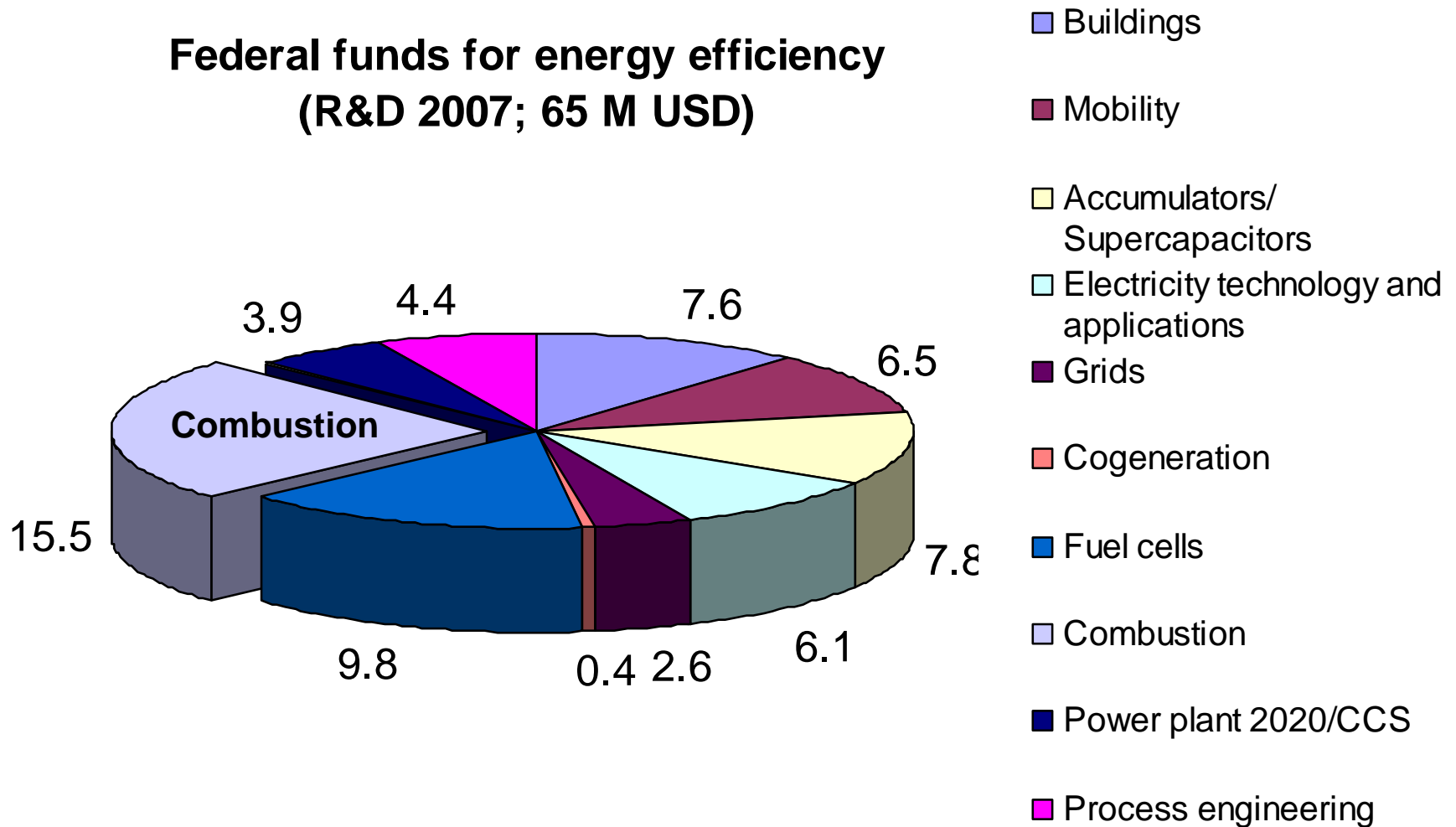
**Triplification of the use of biomass as an energy carrier**



# Energy Research in Switzerland

## Research Programmes

**Federal funds for energy efficiency  
(R&D 2007; 65 M USD)**

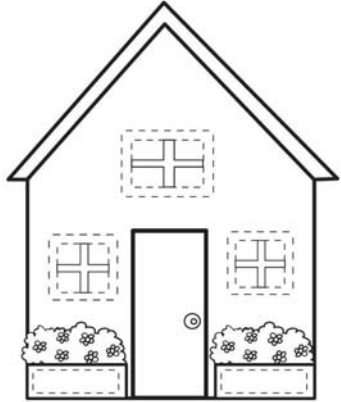






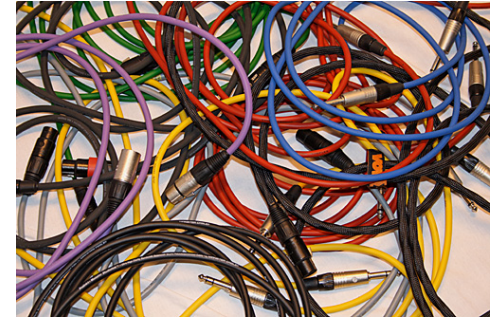
# Energy Research in Switzerland

## New focuses in research programmes 2012-2016



### Preliminary titles:

- „Habitation of tomorrow“
- „Electric systems of tomorrow“
- „Processes of tomorrow“
- „Mobility of tomorrow“





# Combustion Research in Switzerland Importance

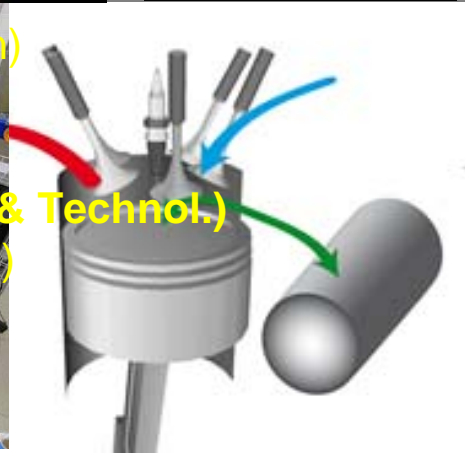
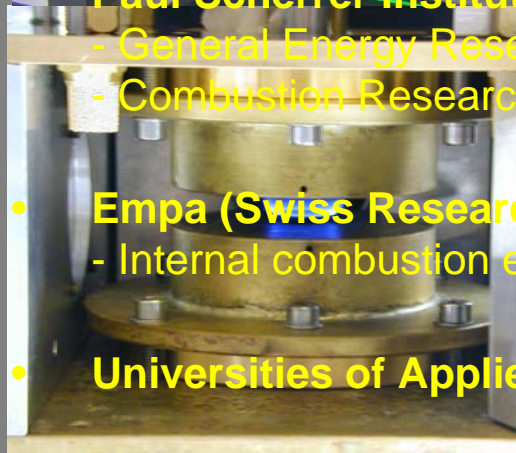
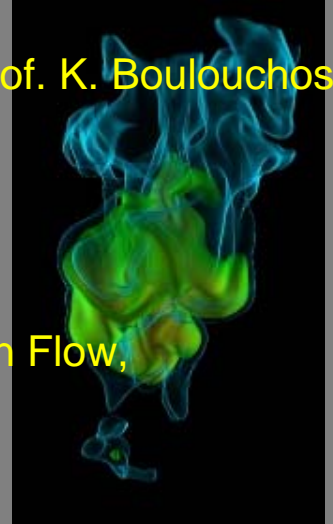
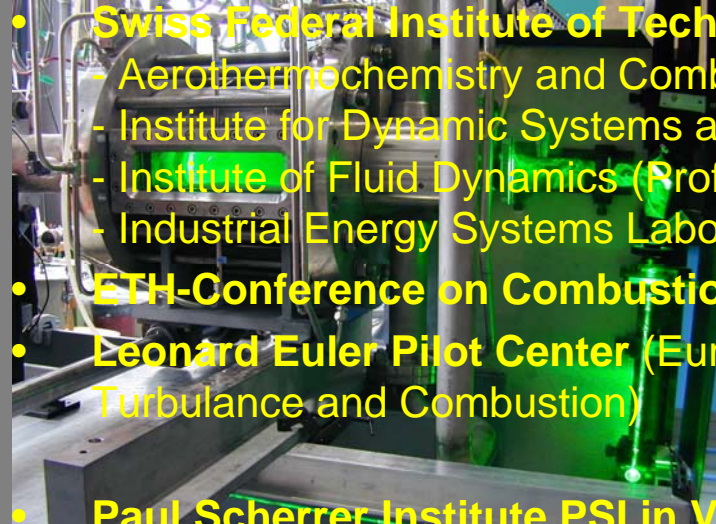
- **Most important process for converting energy**
  - 75 % (85%) Consumed energy produced via combustion
  - various energy sources (fossil fuels, renewable, waste)
  - usable are electricity and heat; to use both is important
  - the fossil fuels will be used; sooner or late
- **Economic importance**
  - 5000 Employees in combustion related industry in Switzerland
  - 2 million USD turn over
  - research centres from international operating companies
- **Research expertise in industry**
  - **Wärtsilä** Research & Development Centre 2-Stroke Marine Diesel
  - **Alstom Power Systems** ( Gas Turbine)
  - **Liebherr** Heavy Duty Diesel Engines (Research, Development & Production)
  - **Iveco** (Fiat) Powertrain Research & Development (Trucks, Heavy Duty, Marine)
  - **ABB Turbo Systems** (turbo charger)
  - Kistler Instruments, Hug Engineering, Wenko Swissauto,





# Competence in Universities and Research Institutes

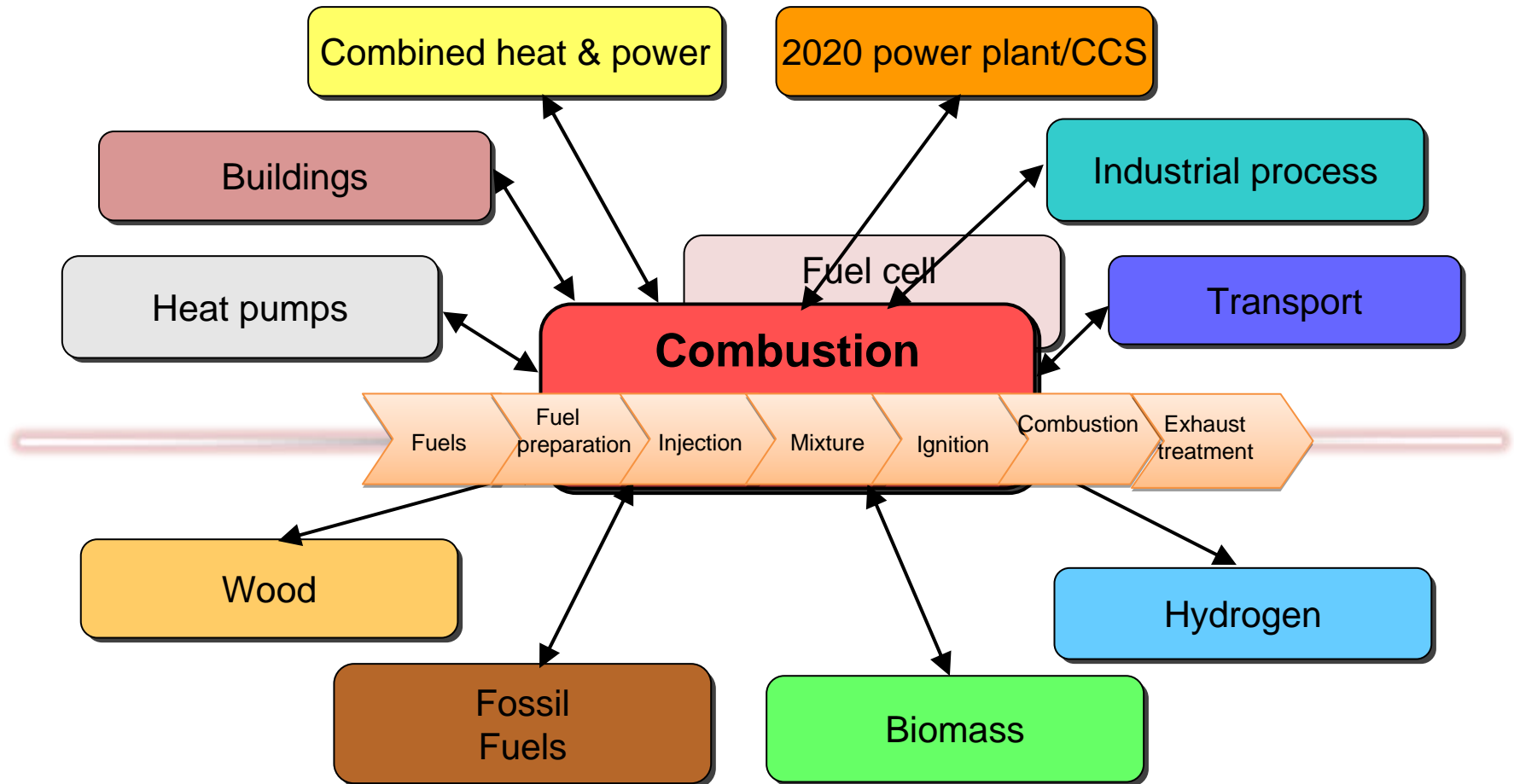
- **Swiss Federal Institute of Technology ([www.ethz.ch](http://www.ethz.ch))**
  - Aerothermochemistry and Combustion Systems Laboratory (Prof. K. Boulouchos)
  - Institute for Dynamic Systems and Control (Prof. L. Guzzella)
  - Institute of Fluid Dynamics (Prof. P. Jenny)
  - Industrial Energy Systems Laboratory (Prof. Favrat)
- **ETH-Conference on Combustion Generated Nanoparticles**
- **Leonard Euler Pilot Center** (European Research Community on Flow, Turbulence and Combustion)
- **Paul Scherrer Institute PSI in Villigen ([www.psi.ch](http://www.psi.ch))**
  - General Energy Research Department (Prof. A. Wokaun)
  - Combustion Research Laboratory (P. Jansohn)
- **Empa (Swiss Research Institute in Materials Science & Technol.)**
  - Internal combustion engines research centre (Chr. Bach)
- **Universities of Applied Science (several)**







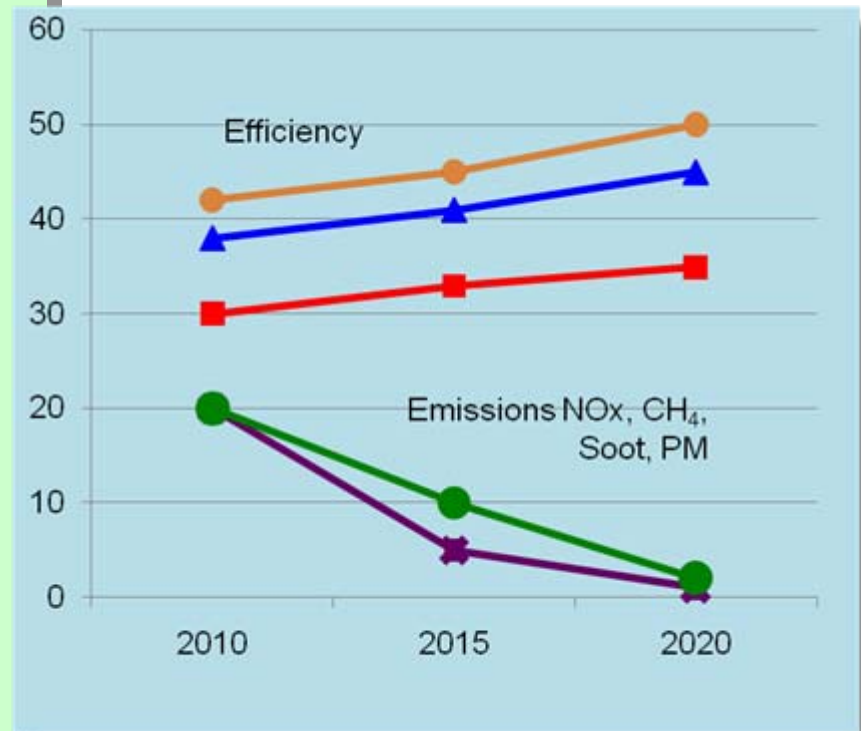
# Interfaces to other SFOE Research Programmes





# Technical and Economic Objectives

- **Reduction of specific CO<sub>2</sub> emissions**
- **Increase of (system) efficiency**  
reduce specific energy consumption  
(preservation of resources, economic viability)
- **Reduction of emissions of pollutants**  
(including particulate matter) to meet  
constantly more stringent regulations
- **Use of various energy sources**  
(especially biogenic forms)
- **Competitiveness of combustion  
systems for biogenic energy sources**





# Research Priorities from 2008 to 2011

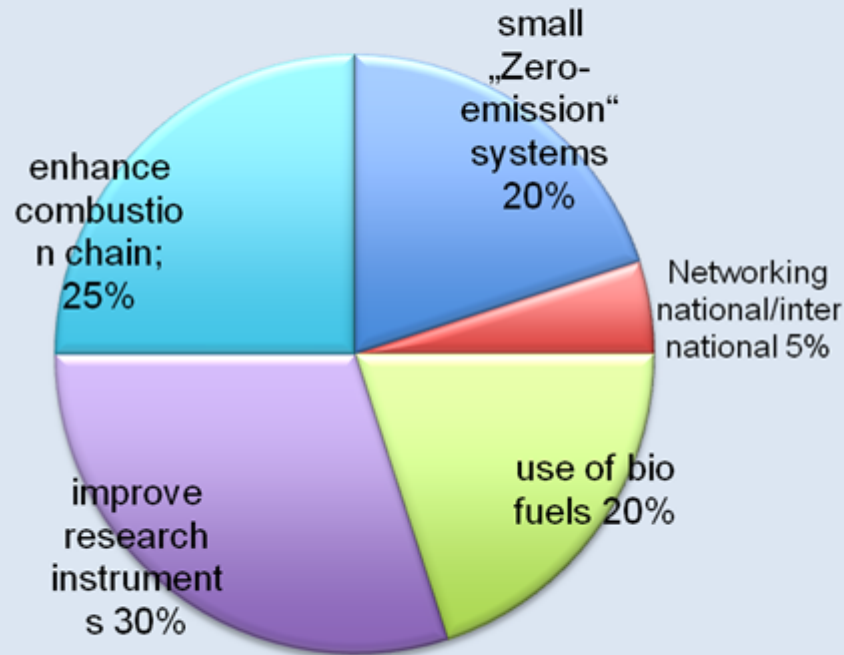
---

1. **(Continue) Development of research methods and instruments**
  - Physical fundamentals of combustion
  - Numeric simulation
  - Measurement methods for test models or applications
  - Development of test models
2. **Development of robust models (focus on computational reactive fluid dynamics) for application in the development, optimisation and diagnosis of new combustion systems** (from fundamentals in need of improvement through to practical applications)
3. **Promotion of networking of experimental and numeric methods for optimising the overall system encompassing engine / exhaust / treatment.**
4. **Depiction of zero-emission systems for small-scale (10 to 100 kW) combined power production (electricity / heat / refrigeration), including heat pumps and biomass**
5. **Optimisation of fuel preparation and combustion, and minimisation of pollutant emissions from (partial) use of biogenic fuels**
6. **Improve networking among stakeholders in the swiss combustion research competence**



# Finances

## Partition SFOE Funds 2008 - 2011



## Finances 2009 (USD)

SFOE	750'000.-
Project Applicant	1'000'000.-
Third party	<u>1'200'000.-</u>
Total	2'950'000.-
Part SFOE	<b>25%</b>

## Federal Funds

for Combustion Research  
➤ **15.5 million USD/year**

## Industry

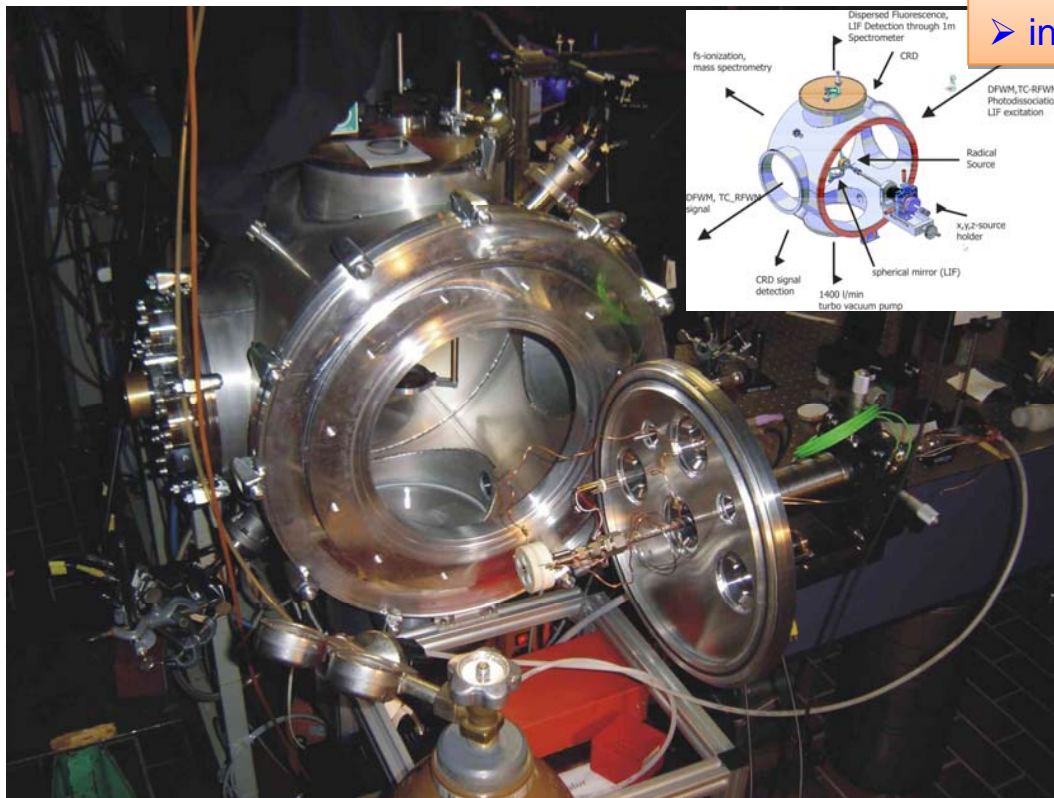
➤ depending on the classification between  
**50 – 200 million USD/year**



# Examples of Combustion Research (1/3)

Investigation of reactions and species dominating low temperature combustion (**PSI**)

- characterisation of species that govern ignition
- investigation of peroxy radicals



## Aims:

- Measurement of molecular features (binding energies and micro canonical rates) for molecules and radicals (e.g.  $\text{H}_2\text{CO}$ ,  $\text{HO}_2$ ) that can be directly compared to theoretical predictions.
- Application of the measurement techniques to alkyl peroxy radicals in order to improve the database of a class of molecules playing a dominant rôle in combustion and atmospheric chemistry.

## Cooperation:

Paul Scherrer Institute (PSI)  
University Birmingham (UK)  
University North Carolina (US)

### *Molecular beam apparatus for multiplex spectroscopy*

Investigation with the beam apparatus at the single photon, vacuum ultraviolet, measurement at the SLS/VUV beamline started at PSI in 2008





# Examples of Combustion Research (1/3)

## Lattice Boltzmann Method for Simulation of Chemical Reactive Systems at microscale (ETHZ)

➤ Important for new systems

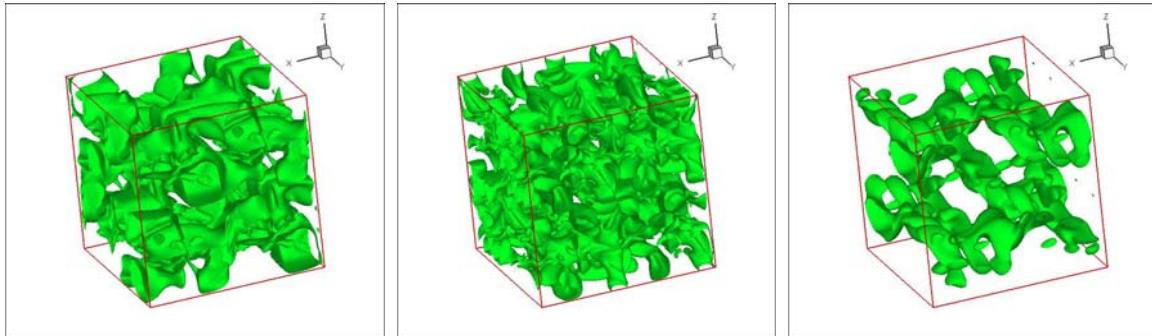
**Aim:** To give a derivation of the multi-speed lattice Boltzmann models which would enhance accuracy of the present standard models and allow for a novel class of simulations of thermal and multiphase flows.

To massively increase the efficiency of three-dimensional simulations.

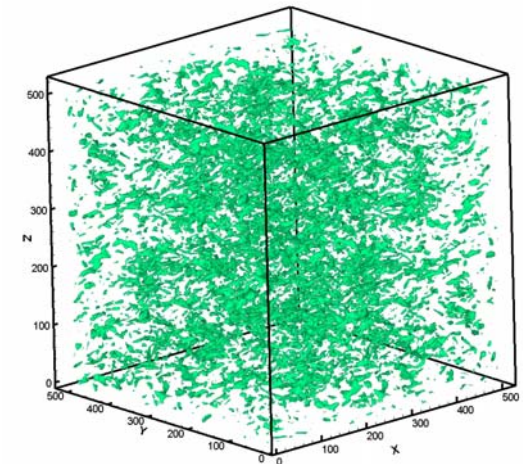
To develop the lattice Boltzmann models for multi-component mixtures.

**Cooperation:** ETHZ, PSI, EPFL, EMPA sowie CNR Rom, University of Leicester, Nanyang Technological University Singapore

### Entropic Lattice Boltzmann Simulation of 3-dimensional flow:



*Taylor Green Vortex Flow bei  $Re = 5000$*



*Kida-Vortex Strömung bei  $Re=20000$ .*

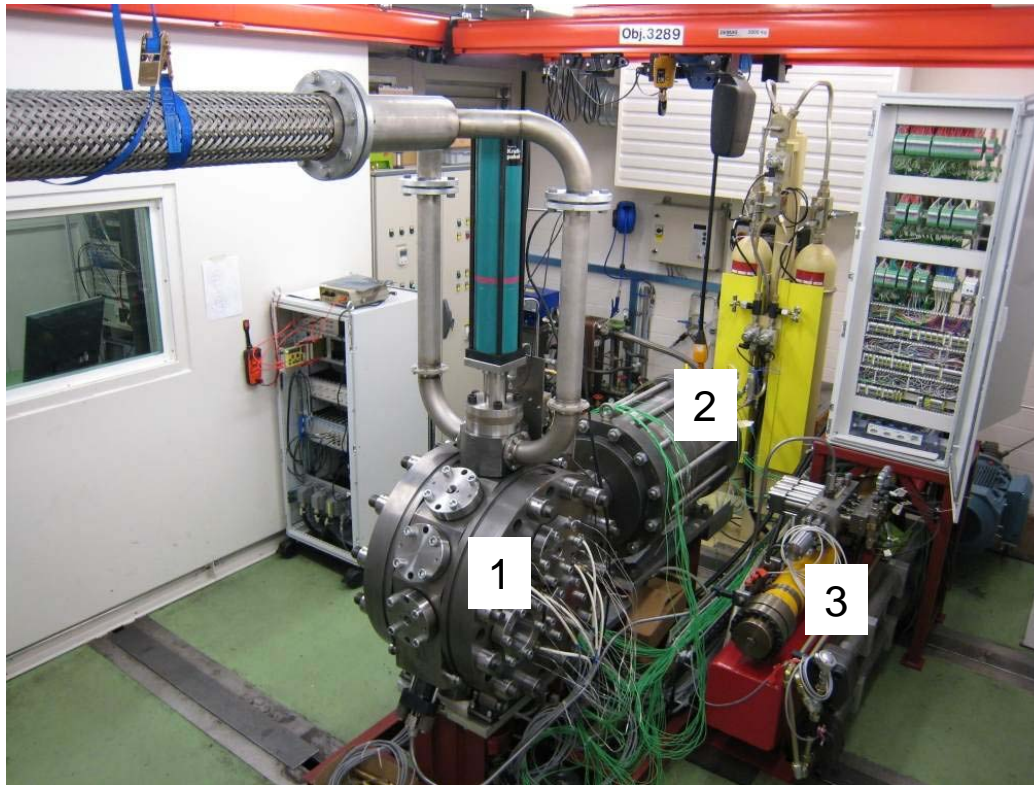


# Examples of Combustion Research (1/3)

## EU-Project *HERCULES* (ETH, PSI, Wärtsilä)

High Efficiency R&D on Combustion with Ultra Low Emissions for Ships (EU FP 6)

➤ **BP Award Health & Environment**



*Spray combustion chamber(1), Preheater/Regenerator (2), fuel injection system (3)*

### **Aim:**

Emission reduction of large (marine) diesel engines

### **Swiss contribution:**

Development of a experimental spray combustion chamber test facility, which represents the combustion system of large two-stroke marine diesel engines

### **Cooperation:**

ETH, PSI und Wärtsilä Schweiz sowie Abo Akademi University, University of Technologie Helsinki, National Technical University Athens

### **Result:**

Successful starting an meanwhile more than 5000 ignitions



# Swiss Presentations at 31. IEA TLM on Combustion

- **National energy and combustion research strategy in Switzerland**  
(S. Hermle & St. Renz, SFOE) **September 20, 12:10h**
- **Spray model assessment by means of high-speed imaging data from novel marine Diesel reference experiment** (Y. Wright, LAV ETHZ) **September 21, 15:40h**
- **Investigation of diesel soot emissions during soot formation during transient engine operation using in-cylinder pyrometry** (P. Kirchen LAV ETHZ) **September 22, 9:30h**
- **Towards a global reaction model for future 'desinger' fuels** (Y. Wright, LAV ETHZ) **September 23, 09:30h**
- **(Co-)Firing of biomass derived H<sub>2</sub>-rich syngas in a gas turbine of an integrated Gasification Combine Cycle (IGCC) system** (P. Jansohn, PSI) **September 23, 16:00h**

