Capture and storage of CO2 with H2 production is a large scale option for future emissions reduction in Europe. Even though relevant technology is available, the increased cost combined with the lack of proper integration with the existing knowledge on H2 based power production or vehicles fuel production are significant handicaps. The CACHET project aimed to develop technologies so that the cost of CO2 capture and hydrogen production using natural gas could be reduced by half.

CACHET investigated four promising technologies, namely advanced stream methane reforming, redox technologies, metal membranes and sorption enhanced water gas shift. Large scale experimental equipment was employed, so that progress towards the technologies scale-up was achieved, through integration of experimental and paper work. In addition, the progress towards financial viability and the assessment of different exploitation scenarios increased the opportunity towards future commercialisation of the technology.

The detailed design of the employed HyGenSys reactor was complex and critical for the proposal success. A double pipe / bayonet tube was selected, which was mounted in a refractory walled and pressurised shell with the heat input from an externalised combustion chamber. Three reactors were initially combined; however, during the project execution the solution was modified, with replacement of the downstream reactor with an air-blown auto-thermal reformer which notably increased the overall productivity rate.

Three alternative concepts regarding chemical looping were examined. One step decarbonisation was an experimental success. Focus was given on testing the iron based material at higher pressure, following an economic analysis. Perovskite based materials were produced and tested, with some of them showing a better performance than the reference material. Scale-up of a pre-existing palladium membrane also took place, along with production and test of electro-less plating on glazed ceramic supports. The membrane process
development unit (PDU) was designed and constructed to confirm the suitability of the membranes and the principles of hydrogen membrane reactors.

Work on the sorption enhanced water gas shift (SEWGS) single column unit was extended to include both adsorption and shift reaction using a simulated syngas feed, while the principle of SEWGS was demonstrated. A multi-column unit was constructed and commissioned as well, producing experimental data through simulation of the full cyclic operation of the SEWGS system. From the data elaboration it was obvious that further investigation was required for the technology to be accurately analysed.

The combination of different efficient technologies was investigated, so that substantial economic benefits could be achieved. In total, 55 different combinations were examined, among which 8 gave the most promising results. The combination study proved that though in some cases the total productivity slightly increased, the increase in cost outweighed the benefits. All four CACHET technologies were assessed in terms of their health and safety, environmental and economical performance.

Given the global research interest towards CO2 capture, various publications and projects using the CACHET technologies where completed during the CACHET execution. In cases where the published data were sufficient a rigorous assessment was made.

Seven proposals for technology improvement have been developed and finalised during CACHET execution, each of them having higher efficiency compared to the state-of-the-art base case. The numerous findings of the project could be summarised as belonging to the following fields:
1. alternative operation system of the HyGenSys technology through the use of nitrogen recirculation;
2. innovative internals and burners for the heat exchanger and the reactor of HyGenSys;
3. new process for hydrogen production with CO2 capture and recycling of the unconverted methane;
4. novel oxygen carriers for chemical looping reforming and one step decarbonisation;
5. development of new process configuration for one step decarbonisation;
6. techniques for thin film Pd-membranes fabrication;
7. innovative reactors integrating membrane and catalyst;
8. improvements of the SEWGS cycles, e.g. development of new cycle with high pressure recovery of CO2 and
9. process schemes integrating two or more CACHET technologies.