Annex Proposal: Optimised Industrial Process Heat and Power Generation with Thermal Energy Storage

1. Background.

Previous activities in the IEA Implementing Agreement "Energy Conservation through Energy Storage" has achieved significant progress in thermal energy storage technologies for energy savings and for reduction of peak demand of energy in buildings and in advancing the prospects of cooling with TES technologies.

The potential for thermal energy storage and regenerative heat transfer for the industrial process heat sector for efficient energy utilisation, heat recovery and storage of high temperature waste heat as well as the need for energy storage for power generation based on new conversion techniques and renewable energy resources (RES) is a concern of several national and international research strategies. Both areas are directed to applications and processes at high temperature. In this context "High Temperature" is defined to be higher than 120 °C as required for comfort heating and where water cannot be applied as heat transfer fluid.

Nevertheless, no or very few examples of commercial high temperature thermal energy storage (HTTES) are realised. Main reasons are the still too high investment costs of the existing HTTES technology which leads to non economic systems. In order to achieve the required cost reduction the realisation of long-term stable, low cost storage materials with superior thermo physical properties, the development of a high efficient and economically optimised heat exchanger configuration and innovative storage design are required. In the same way, the development of optimised integration and operation strategies for the specific application are essential.

Currently, international research activities in the field of HTTES are fragmented with respect to the investigated storage technique and TES material development as well as to the considered power level, range of thermal capacity and temperature range.

Important applications for high temperature heat storage can be found in the industrial process heat sector. Depending on the temperature range and the dominating heat transfer fluids, two different areas are identified. A huge amount of energy in the temperature range of 100-300°C is needed to generate process steam at low or intermediate pressure for application in food processing, manufacturing of construction materials, production of cardboard and paper, in the textile industry, manufacturing of rubber and other commodities. For such applications improved PCM/steam storage systems could lead to economic TES solutions. For elevated temperatures above 500/600 °C flue gas and process air are the dominating heat transfer fluids. Due to the poor heat transfer characteristics of gas/air the development and design of high efficient heat transfer technique represent an additional important task for the realisation of economic HTTES technology.

With increasing amount of electricity generated by RES feeding into the interconnected grids, considerable grid stability problems come up. For solar thermal power plants the integration of thermal energy storage avoids such interconnection and frequency stability problems by stabilising solar power generation within the fence of the solar thermal plant. For stand alone solar thermal plants in remote or island power parks, energy storage is the fundamental element to maximise capacity factor and to assure availability. In case of wind power,

electricity has to be stored to make up for the inherent variability of wind. As an alternative to storing electricity the "Advanced Adiabatic Compressed Air Energy Storage (CAES)" is being developed by a European consortium. The core component of the AA-CAES concept is an efficient high temperature heat storage device necessary to enable effective and economic adiabatic CAES technology. With respect to power generation with fuel cells there is considerable demand for thermal management and HTTES especially for the operation of high temperature solid oxide fuel cells.

2. Objectives.

The general objectives of the proposed Annex" Optimised Industrial Process Heat and Power Generation with Thermal Energy Storage" are to overcome the fragmented research and to achieve synergies from existing and new future HTTES activities.

The objectives of the work to be performed under this Annex are:

- To conduct a general review and assessment study of existing and emerging HTTES technologies
- To identify obstacles that need to be overcome to make industrial process heat and power generation with TES more economically and environmentally viable
- To identify efficient and economic storage materials
- To compare and assess different HTTES concepts and design
- To define strategies for efficient storage integration and operation
- Technology transfer

3. Work programme.

The work in the framework of this Annex is planned for a period of 3 years (with expected start after approval by the ExCo in late fall 2004) and subdivided in subsequent phases. For each phase an indication is given of the time required to carry out the activities.

Phase 0: Pre-definition Phase
January-October 2004

- Invitation to participate, clarification of interest and participation
- Kick-off workshop in June or July 2004 (organized by DLR) – establishing participants and their combined goal with the annex
- Collecting information on ongoing activities in this area, compiling State-of-the-Art of HTTES technologies

Phase 1: Start up and Task Definition Phase (time required 6 months)

- Finalizing Annex Objectives, Goals and Work Plan with ExCo
- Finalizing Financing Plans for participants
- Establishing collaboration activities
- State of the Art Reviews
- Workshop and Expert Meeting

Phase 2: Review and Assessment Phase (time required 15 months)

- State of the Art Reviews (continued)
- Technical and economic assessment of different HTTES concepts
- Identify of applications with high potential for economic HTTES integration
- Case Studies
- Evaluation of the concepts and applications
- Workshop and Expert Meetings

Phase 3: Development and Implementation Phase (time required 15 months)

- Case Studies and Pilot projects (continuation)
- Defining candidate technologies for power generation and process heat
- Establishing desired feasibility studies and demonstration projects – a plan for future IEA activities
- Initiation of energy storage projects related to industrial process and power generation
- Workshop and Expert Meetings
- Final Report and Dissemination of Results

4. Costs involved.

The work will be carried out on Task Sharing Basis.

To carry out the activities described in this Annex, the level of effort per participating country is estimated to be about 3 person months per year. In addition to this, about 4 person months per year is required for the specific tasks of the Operating Agent.

5. Operating Agent.

To be determined by the ExCo.

In case, Germany will contribute with a considerable project, DLR has the experience and capability to take over the role of the OA.

6. Participating countries.

To be determined.