

electricity use in the residential sector. A survey of the existing residential buildings has been conducted to establish typical design features. Based on these typical design variables, computer simulation techniques are used to estimate the likely energy savings from two energy efficient measures – the use of tinted glass to reduce solar heat and the application of thermal insulation to the external walls to lower heat conduction. The building energy computer program DOE-2 was used to predict the electricity savings for the 11-year period from 1997 to 2007. It has been found that the electricity savings are small during the initial years, about 0.2% of the total electricity use in the residential sector in 1997. However, as older buildings are replaced by newer ones with more energy efficient design features, the energy savings in subsequent years will have a bigger impact on the overall electricity use situation in the residential sector.

00/00592 The state significance of energy saving in buildings and principles of support programs in Lithuania

Klevas, V. and Zinevicius, F. *Energy Policy*, 2000, 28, (11), 791–798. This paper analyses by Lithuanian example multiflat houses problem which exists in most Central and Eastern Europe countries. Demand for heating in these houses is two or more times higher than in those in Western countries. Delay with solving of this problem has serious economic consequences. The problem is complicated because of the realization that heat saving potential is closely connected with the necessity to technical, economic and organizational reconstruction of district heating systems. State support for heat saving in buildings should be co-ordinated with programmes of technical reconstruction and organizational reorganization of district heating systems. A scenario for preparing district heating reconstruction programmes is proposed in which thermal renovation of buildings should be an integrated part.

00/00593 Thermodynamic and physical properties of mixtures of refrigerants and oils

Mermond, Y. *et al. Int. J. Refrig.*, 1999, 22, (7), 569–579. In order to detect the thermodynamic and transport properties of lubricating oils and of refrigerant and oil mixtures, predictive models have to be used, because of the effect of lubricants circulating within the refrigerating plant on boiling and convective condensation mechanisms and the shortage of data supplied by the manufacturers. Data obtained from the literature is compared with the results from the study.

00/00594 Thermodynamic simulation and analysis on adsorption air conditioning system driven by exhausted gas in automobiles

Tan, Z.-C. and Wang, R.-Z. *Shanghai Jiaotong Daxue Xuebao*, 1999, 33, (8), 922–927. (In Chinese) Presented in this paper are the characteristics of an adsorption air conditioning system driven by the exhausted gas produced by automobiles. An analysis of heat transfer in heated/cooled fluids and adsorber is developed by numerical methods. The temperature field and heat transfer in the adsorber are obtained. It is found that the 'heat pipe effect' is apparent in isosteric heating and isosteric cooling stages, which can greatly enhance the effectiveness of heat transfer. A discussion is also included on several factors, such as working conditions and physical characteristics of adsorbent, which influence the performance of the system. It is stressed that the key technologies in this system are the enhancing of the effective thermal conductivity of the adsorber and decreasing the contact resistance.

00/00595 Typical weather data of main Turkish cities for energy applications

Üner, M and Ileri, A. *Int. J. Energy Res.*, 2000, 24, (8), 727–748. Energy consumption and performance investigations of environment-dependent systems such as building HVAC and refrigeration systems, solar collectors, cooling towers, usually require weather information. This introduces a problem because there may be significant variances between the recurrent days or years. In this work, typical hourly weather data for the selected 23 provinces that represent demographic and climatic conditions of Turkey are obtained by using actual recordings. The results are stored as computer files ready to be used by simulation programs. By using these typical meteorological years, heating and cooling degree-days, dry-bulb temperature bins and winter and summer design dry-bulb temperatures are calculated. Sample typical-year simulations show for example that energy savings of about 11 and 16% could be expected in Ankara by 3 and 5 k night-setback, respectively.

14 HEAT PUMPS

00/00596 An economic and technical case for a compressor/expander unit for heat pumps

Henderson, P.C. *et al. Int. J. Energy Res.*, 2000, 24, (9), 831–842. Despite their obvious environmental benefit, heat pumps in general have difficulties in penetrating the heating market because of the high initial capital cost. However, given the fact that in the U.K., space heating alone accounts for nearly 50 per cent of all the primary energy used, the universal adoption of heat pump subsidies similar to those offered by certain German utilities for example would be an effective contributor to the reduction of greenhouse gas emission. However, it would be improper for subsidies alone to be the only mechanism by which heat pumps could gain the scale of market acceptance necessary in order to make the required greenhouse gas emission cuts. Therefore, a new generation of heat pumps must have a superior performance than existing units operating with HCFC R22 or R407c. The use of R410a can aid heat pump market penetration by having heat pumps of a superior performance and a smaller size. However, to make full use of R410a, the difficulties of the relatively low critical point must be overcome and the use of a novel compressor/expander unit is illustrated.

00/00597 Extended mechanical efficiency theorems for engines and heat pumps

Senft, J. R. *Int. J. Energy Res.*, 2000, 24, (8), 679–693. Previous work carried out by the author has established basic theorems relating the mechanical efficiency of an engine to its thermodynamic cycle, external pressure and the effectiveness of its mechanism. That work treated the elementary single-workspace reciprocating piston heat engine. This paper extends the analysis to cover more complex engine types and heat pumps, including double-acting and split-workspace devices. Theorems are derived which allow best-possible estimates and broad comparisons of the overall performance of a large variety of thermomechanical machines. Examples from the field of Stirling engines illustrate the application of the main results.

00/00598 Reduction of the wear and corrosion of pumps and piping by suitable selection of materials

Joppien, H. *Eur. Comm., [Rep.] EUR*, 1999, 1–98. (In German) Different methods have been successful for decreasing the wear and corrosion, and thus reducing the repair and maintenance costs, of pumps and piping, especially for operation in coal mines. The use of Ni-Hard-4 steel is one of the main solutions to the corrosion problem. The use of ceramic and elastomer coatings, for increase corrosion resistance and increasing working life of wear-prone pumps has been suggested for novel pumps. The degree of erosion of equipment is influenced significantly by the substitution of older pumps as well as an optimum retrofitting of pumps. In addition, the use of lubricating slide ring seals can also result in increased pump life and lower maintenance costs.

00/00599 Thermal performance of a solar-aided latent heat store used for space heating by heat pump

Mehmet, E. *Solar Energy*, 2000, 69, (1), 15–25. In this study, the cylindrical phase change storage tank linked to a solar powered heat pump system is investigated experimentally and theoretically. A simulation model defining the transient behaviour of the phase change unit was used. In the tank, the phase change material (PCM) is inside cylindrical tubes and the heat transfer fluid (HTF) flows parallel to it. The heat transfer problem of the model (treated as two-dimensional) was solved numerically by an enthalpy-based finite differences method and validated against experimental data. The experiments were performed from November to May in the heating seasons of 1992–1993 and 1993–1994 to measure both the mean temperature of water within the tank and the inlet and outlet water temperature of the tank. The experimentally obtained inlet water temperatures are also taken as inlet water temperature of the simulated model. Thus, theoretical temperature and stored heat energy distribution within the tank have been determined. Solar radiation and space heating loads for the heating seasons mentioned above are also presented.

00/00600 Water desalination using heat pumps

Siqueiros, J. Holland, F. A. *Energy*, 2000, 25, (8), 717–729. The USA/Mexico border areas have very limited water resources with salinity a major problem. Experimental work on heat pump assisted water purification has been carried out in Mexico since 1981. Initially, electrically driven mechanical vapour compression heat pumps were used. These were subsequently replaced by absorption heat pumps with the objective of developing systems to operate on environmentally clean low grade heat energy. These thermally driven units can either be designed as small scale mobile units to be used in disaster areas or

scaled up in size to produce potable water for cities at a cost competitive with reverse osmosis and electrodialysis technologies. Future work will concentrate on heat driven heat transformer or temperature amplifier systems since these are the most promising from an economic and environmental point of view.

00/00601 Optimum performance of a heat engine-driven combined vapour compression-absorption-ejector heat pump

Göktun, S. and Bayülken, A. *Int. J. Energy Res.*, 2000, 24, (8), 655–664. Optimum performance of an endoreversible heat engine-driven heat pump cycle, based on a combination of an absorption cycle with a vapour and ejector compression cycles is investigated. This combination increases the performance of the conventional ejector and absorption cycles and provides high performance for heating. The analysis show that the combined heat pump cycle has a significant increase in system performance over the heat engine-driven vapour compression or absorption heat pump cycle and heat engine-driven combined vapour compression and absorption heat pump cycle.

15 ENVIRONMENT

Pollution, health protection, safety

00/00602 A 1990 global emission inventory of anthropogenic sources of carbon monoxide on $1^\circ \times 1^\circ$ developed in the framework of EDGAR/GEIA

Olivier, J. G. J. *et al. Chemosphere: Global Change Sci.*, 1999, 1, (1–3), 1–17.

A 1990 global emission inventory of carbon monoxide emissions with $1^\circ \times 1^\circ$ latitude-longitude resolution was compiled on a sectoral basis. The sectoral sources considered include large-scale biomass burning (29%), of which savanna burning, (18%), and deforestation, (11%), fossil fuel combustion (27%), predominantly in road transport), biofuel combustion (19%), predominantly fuel wood combustion), agricultural waste burning (21%) and industrial process sources (4%). The inventory was compiled using mostly national statistics as activity data, emission factors at global or country level, and specific grid maps to convert, by sector, country total emissions to the $1^\circ \times 1^\circ$ grid. A special effort was made to compile a global inventory of biofuel use, since this was considered to be a significant source on a global level and a major source in some regions such as India and China. The global anthropogenic source of CO in 1990 is estimated at about 974 Tg CO yr⁻¹.

00/00603 A model analysis of clean development mechanisms to reduce both CO₂ and SO₂ emissions between Japan and China

Shimazaki, Y. *et al. Applied Energy*, 2000, 66, (4), 311–324.

It is necessary for Japan to support the development of desulfurization policies of China to solve global and local environmental problems. This study proposes a 'double clean development mechanism' to reduce both CO₂ and SO₂ emissions at the same time. The purpose of this study is to investigate the consequences for both countries' energy economies of following double clean development mechanism between Japan and China. A dynamic optimization model is developed to estimate the effects of Japanese investments in China for carbon dioxide recovery-disposal and emission desulfurization technologies. The simulation results suggest that a double clean development mechanism can effectively mitigate the damage caused by SO₂ emissions because the clean development mechanism itself can reduce SO₂ emissions, e.g. by switching to fuels. However, China might not be willing to accept restrictions on SO₂ emissions. This study also examines whether China will be able to maintain high growth rates with a clean development mechanism under the CO₂ and SO₂ restriction. The analysis shows that increasing the upper limit of investment from Japan to China can enhance the economies of the both nations. The effect of nuclear power installation on economic performance is also investigated for the both nations.

00/00604 A toxicological review of polycyclic aromatic hydrocarbons

Pickering, R. W. *J. Toxicol., Cutaneous Ocul. Toxicol.*, 1999, 18, (2), 101–135.

This paper is a toxicological review of polycyclic aromatic hydrocarbons. The discussion includes the mechanisms of chemical carcinogenesis, coal tar, exposure in workplace and interactions with DNA, benzo[a]pyrene.

00/00605 Advanced reburning measurements of temperature and species in a pulverized coal flame

Tree, D. R. and Clark, A. W. *Fuel*, 2000, 79, (13), 1687–1695.

An experimental programme has been completed where detailed measurements of a pulverized coal flame with advanced reburning have been obtained. Maps of species (CO, CO₂, O₂, NO, HCN, and NH₃), temperature, and velocity have been obtained consisting of approximately 60 measurements across a cross-sectional plane of the reactor. Two maps at a single operating condition were obtained and are compared. In addition to the mapping data, effluent measurements of gaseous products were obtained for various operating conditions, while investigating the affect of reburning zone stoichiometric ratio (SR), ammonia nitrogen to NO ratio (NSR), ammonia injection location, and burner swirl. Advanced reburning was achieved by injecting natural gas downstream of the primary combustion zone to form a reburning zone followed by ammonia injection and then tertiary air. The data showed advanced reburning was more effective than either reburning or NH₃ injection alone. At one advanced reburning condition (SR = 1.05, Swirl = 1.5, NSR = 2.5) over 95% NO reduction was obtained. Ammonia injection was most beneficial when following a reburning zone which was slightly lean, SR = 1.05, but was not very effective when following a slightly rich reburning zone, SR of 0.95. In the cases where advanced reburning was most effective (reburning SR = 1.05), higher NSR values improved NO reduction, but the effect of NSR was secondary to NH₃ injector location. The optimal location for injection was found to coincide with changes in the temperature field. The mapped temperature, species and velocity data for advanced reburning showed that the largest drops in NO occurred in a region where the O₂ concentration was between 0.7 and 3.0%, NH₃ was between 0 and 2961 ppm, and temperatures were between 1274 and 1343 K. These are similar to optimal conditions known for SNCR. Significant NO reductions were seen when NSR values were near one, suggesting NH₃ was very effective at NO reduction when surrounding temperature and species conditions were favorable. Because this was only one detailed set of data, it is difficult to conclude that these conditions are optimal or need to exist for optimal NO reduction. More detailed mapping data at other operating conditions would be useful in identifying optimal advanced reburning conditions.

00/00606 Analytical procedure for carbon tax evaluation

Borchiellini, R. *et al. Energy Convers. Manage.*, 2000, 41, (14), 1509–1531.

In this paper, an analytical procedure for carbon tax evaluation is presented. The aim is the assignment to energy plants of a charge linked to their CO₂ emissions. The problem is faced through the use of an environmental approach, including evaluation of the cost of the exergy destroyed inside the system and the cost of exergy rejected to the biosphere with the plant wastes (efficiency penalty) coupled with evaluation of the index of CO₂ emission herein defined. In this way, the procedure allows a cost of the emitted CO₂ to be obtained based not on political considerations but only on efficiency and exergy analysis. The aim is to reward the efficient use of energy resources and to penalize the inefficient plants. The procedure is applied for the analysis of three typical Italian energy plants burning fossil fuels: a 320 MW coal steam plant; a 700 MW natural gas combined plant; and a 30 MW gas turbine cogeneration plant. The plants are analysed using an environmental optimization and taking into account all their pollutant emissions (CO, NO_x, SO_x and CO₂). The values of the CO₂ emissions charges obtained with the proposed procedure are presented and discussed in depth and a comparison with the possible costs of CO₂ sequestration activities is presented too.

00/00607 Annex I commitments: adverse economic impacts on developing countries: myth or reality?

Pathak, M.K. *et al. Energy Policy*, 2000, 28, (9), 641–649.

This document examines the claim that legally binding commitments undertaken by Annex I Parties to reduce greenhouse gas emissions would result in adverse economic impacts on developing countries. This is examined through the case of the Indian economy. The impact of a range of carbon taxes on trade between India and the US (a major trading partner) is analysed, using a partial, static framework. This study reveals that impacts on India of commitments of Annex I countries to comply with emissions reduction targets *prima facie* are marginal. However, economies importing capital intensive products from Annex I countries are likely to have adverse second-order impacts. In such a scenario, there is a case for increased south-south trade with increased flows from countries with a large industrial base. Higher costs in Annex I countries will have a two-fold effect on