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THE 2000 WATT PER CAPITA INDUSTRIAL SOCIETY - REDUCING RISKS OF ENERGY SUPPLY BY SUBSTANTIAL USE OF ENERGY AND MATERIAL EFFICIENCY

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Overview

In the coming decades, reaching the depletion mid-point of oil, the re-concentration of crude oil production in the Near East, and the impacts of climate change will compel industrialised and emerging countries to think in alternatives of technological, but also entrepreneurial solutions and related polices. Generally, the search for solutions is focused on energy supply options whether renewables energies, nuclear energy, or carbon capture and storage from centralised fossil fuel using energy converting plants. These options have their specific characteristics such as limited potentials, relatively high cost, limited public acceptance, low market shares, intermittent supply. Because of these characteristics there are substantial risks of price or cost increases or of insufficient energy supply in the next decades and besides the economic burden additional external cost which may even include geopolitical activities and regional wars.

Little attention is still given to the role of the strategic option using material and energy much more efficiently during this century and exploring the technological option of efficiency by major technological break through and technological substitution (instead of technical improvements). These technological changes by substantial efficiency gains during this century – also labelled as the 2000 Watt per capita society – do not only involve new technical solutions, but also entrepreneurial changes and political realms. With increasing energy and material prices (a first experience being given during the period 2004 and 2005) demand for highly energy- and material-efficient technologies is likely to rise steeply, and firms (or countries) that can provide them will prosper.

The paper reports first on efficiency potentials in energy's transformation from primary energy to useful energy and, more importantly, from useful energy to energy services. The latter involves all forms of material efficiency and substitution reducing the demand for useful energy. Secondly, the paper outlines the impact of exploiting these energy and material efficiency potentials on global energy demand assuming that a shift in energy and innovation policy takes place. The reduced global energy demand relative to the recent IEA scenarios is computed for the next four decades and the postponement of the depletion mid-point and of energy-related greenhouse gas emissions is calculated as well as the slow down of the reconcentration of oil production in the Middle East. The paper also assumes a decrease of the global second hand markets of energy-intensive investment goods and vehicles being presently sold to emerging and developing countries.

Methods

The examination of the potentials considers the lifetimes of manufactured artefacts (buildings and infrastructure that will save or waste energy in 2050 are being built today). The methods used are in depth technological analyses in all energy using sectors and in some major production sectors of energy-intensive mass materials and their energy implication in mobile uses (Jochem et al. 2004). Taking the results from Switzerland as a representative of industrialised countries for the period of five decades, the potentials are also applied to other industrialised and emerging countries by using a sectoral model of those countries and world regions. The reduced primary energy demand of 2030 and 2050 is compared to a reference scenario from the World Energy Outlook of the IEA; the difference of accumulated use of oil, natural gas and coal is calculated to identify the stretching of oil and gas resources, the slower re-concentration of oil production and the accumulated energy-related greenhouse gas emissions.

Results

(1) Achieving 2000 Watt per capita in industrialised countries in the second half of this century implies a complete re-investment of the capital stock (and a complete refurbishment of the building stock). (2) In light of these requirements, energy R&D must be understood to encompass all technical systems that use energy during their operation and production phases, not solely energy conversion technologies. (3) Reducing current per capita energy demand by two-thirds requires not only research in natural and technical sciences but also behavioural research on decision making and daily operation and innovation in industry, services, transportation, and private households.

Contributions to these enormous efficiency gains will have to come from all sectors and technical systems but also from changed behaviour of many actors: e.g. buildings (insulation, heat pumps), large equipment in industry (new physical, chemical and biotechnological processes instead of conventional thermal separation and synthesis processes), transport (light weight vehicles, further advances of traditional propulsion systems, introduction of the fuel cell, or telematics), and more efficient use of energy-intensive materials, material recycling and re-use of components of products, or intensification of product and vehicle use by new entrepreneurial and professional services.

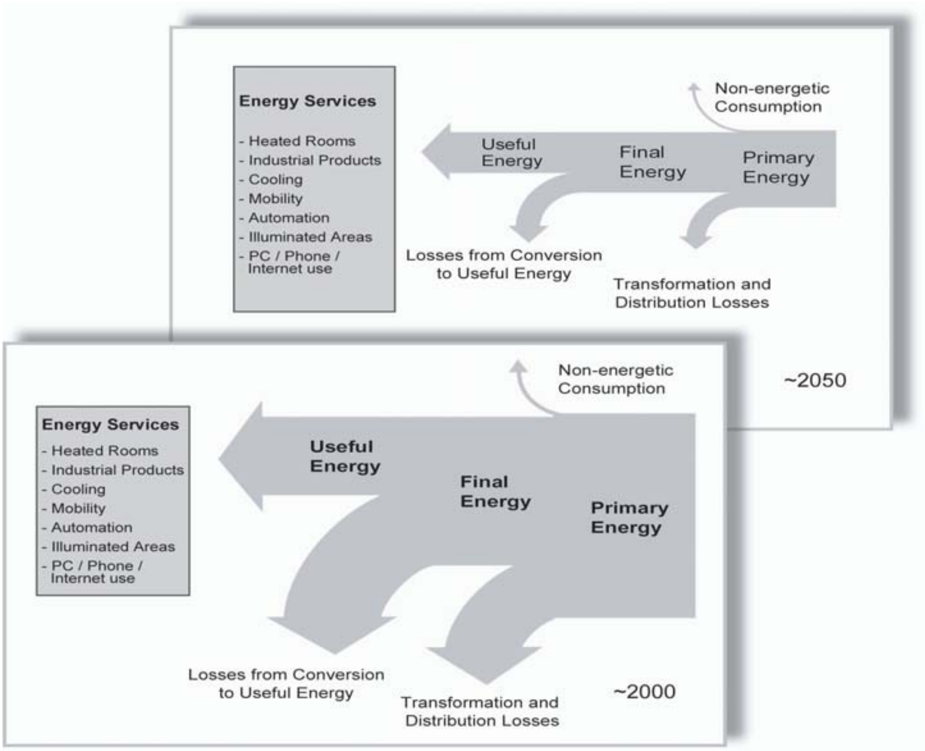

Figure 1: Energy flows and energy services of Switzerland in 2000 and 2050 – reducing energy per capita demand by two thirds while increasing energy services (or income per capita) by two thirds

Conclusions

The transition to a 2000 Watt per capita industrial society would need the support of a fundamental change in the innovation system (e.g. research policy, education, standards, incentives, intermediates and entrepreneurial innovations). The innovation system would have to be continuously evaluated and improved over the coming decades with the perspective being part of a policy on sustainable development at the national and multi-national level. The efficiency impacts would substantially reduce the risks of high energy prices, give more time and open up more opportunities for the application of renewables, substantially decrease the accumulated global CO_2 emissions and related adaptation cost.

References

Jochem, Eberhard (2004) „Steps towards a sustainable development - A White Book for R&D of Energy-Efficient Technologies". CEPE/ETH and novatlantis Zurich, Switzerland

Jochem, Eberhard (2004) „R&D and Innovation Policy – Preconditions for making staps towards a 2000 Watt society" Energy&Environment 15(2004)2, 283-296

Marechal, F.; Favrat, D., Jochem, E. (2004) „Energy in the perspective of the sustainable development" Journal of Cleaner Production 12(2004)5, 1-20