2 Introduction and Foreword

„Tell people something they know already and they will thank you for it.
Tell them something new and they will hate you for it.“ George Monbiot

„Climate change is a problem with unique characteristics. It is global, long-term (up to several centuries), and involves complex interactions between climatic, environmental, economic, political, institutional, social and technological processes. This may have significant international and intergenerational implications in the context of broader societal goals, such as equity and sustainable development. Developing a response to climate change is characterised by decision-making under uncertainty and risk, including the possibility of non-linear and/or irreversible changes. This report confirms the finding that earlier actions, including a portfolio of emissions mitigation, technology development and reduction of scientific uncertainty, increase flexibility in moving towards stabilisation of atmospheric concentrations of greenhouse gases.” <1>

It was made clear in the Greenpeace report “Fossil Fuels and Climate Protection: The Carbon Logic”<2> that we need to drastically reduce our emissions of carbon dioxide to within tolerable levels, which must lead to a total phase out of the use of fossil fuels. The Carbon Logic report introduces the concept of a “carbon budget” which is the amount of oil, coal and gas that we can afford to burn if we are to avoid extensive damage to the environment caused by global warming. Just a one degree centigrade rise in temperatures over the next 100 years would cause significant damage. A temperature rise of more than one °C in that time would result in extensive damage. Greenpeace estimates that the carbon budget, which would keep any global temperature rise to within one °C, would be exceeded in about 30 years at present trends.

To stay within this budget, 75% of recoverable fossil fuel reserves must remain in the ground, never to be used as fuels. This will mean phasing out fossil fuels within this time period.

Without action to reduce emissions, 1500 billion tonnes of carbon will probably be released over the next 100 years, the majority of which will come from burning fossil fuels. This represents an enormous addition to the atmosphere of the potent greenhouse gas carbon dioxide, which began increasing significantly at the beginning of the industrial revolution. The resulting global warming would excessively raise global temperatures, increase extreme weather events, flood extensive areas of land, devastate ecosystems and accelerate extinctions. In Japan, 80% of beaches will disappear if sea levels rise by 65 cm and 90% will go with a rise of one metre<3>.

1. Intergovernmental Panel on Climate Change (2001a).
2. Hare (1997).
3. Harasawa, H. (2001).

Rich, developed nations must take the initiative in order to make this switch because of their historical use of fossil fuels and their currently disproportionate percentage of emissions (Developed nations produce 80% of the world total greenhouse gas emissions from fossil fuels). In addition, developed countries are committed to assisting developing nations as a matter of equity and as part of their international agreements such as the Kyoto Protocol on Climate Change, aimed at reducing greenhouse gases globally.

In reality, our options for energy supply must be constrained by our impact on the environment. Fossil fuels can no longer be burned and nuclear power has proven to be dangerous and expensive and has had a disastrous impact on human health and the environment on a global scale<4>. The disaster potential posed by the nuclear industry with its associated problems of radioactive waste and the threat of terrorism or nuclear accident clearly indicate that this dangerous technology must be discontinued. The Kyoto Protocol climate conference in Bonn also agreed that nuclear power is not part of the Kyoto Protocol, having been excluded from the Joint Implementation and the Clean Development Mechanism<5>. With regard to fusion: In spite of decades of research and billions of dollars spent, nuclear fusion has not proved viable. Even if fusion will function one day it would also involve the production of radioactive waste. Renewable energies, however, offer us a sustainable solution.

2.1) Objectives of the „Energy Rich Japan“ Study

Renewable energy technologies using regional or global sources, coupled with a reduction in energy use by adopting energy efficient technologies, offer the only safe and proven option open to us for future energy needs. The objective of this study is to show that a region such as Japan is able to supply all of its own energy needs with this option, and to use the report to influence the discussion over the change from fossil and nuclear energy sources to a sustainable energy system.

The ongoing discussion regarding the potential of renewable energy and efficient design has been negatively influenced by a lack of facts about the availability and potential of these technologies. Showing that a region can provide its own energy today, purely from renewable sources will help to move us towards a fossil fuel- and nuclear energy-free system. Setting out a framework for a

4. The 1986 explosion at the Chernobyl nuclear power station has been described as "the greatest technological catastrophe in human history". The World Health Organisation (WHO) estimated that the accident released 200 times more radioactivity than was released by the atomic bombs dropped on Hiroshima and Nagasaki. In the first year after the accident 400,000 people had to be evacuated. Large tracts of Ukraine, Belarus and Russia remain heavily contaminated to this day, and even in the UK agricultural restrictions still apply as a result of radioactive contamination from the accident.
5. The COP was held from 16th to 27th July 2001 in Bonn, Germany.

100% renewable energy supply also provides the political and societal inspiration to make moves in the direction of a sustainable future as set out at the Earth Summit in 1992.

There is rapid development within the field of renewable energy and this study presents the best available options open to society today. Naturally, society needs to work further toward improving these technologies technically and economically.

Any energy system must fit with the limitations imposed by the biosphere on a long-term scale. So what are the controls that need to be observed when planning such a system? Among other things, a sustainable energy system must not involve any loss of species. It must promote the correct use of land. It must help protect ecosystems, such as forests, as interconnected and intact living systems, protecting species diversity. It must involve no emissions of persistent, bioaccumulative or toxic wastes, no radioactive wastes and it must embody the principles of equity and equality for the present and future generations[6].

Policies for a sustainable future promote an energy system as defined above. This means, among other things, that biomass has to be produced and used by sustainable methods. This means not degrading soils or displacing other essential uses of land such as forests, and not emitting greenhouse gases such as methane in biomass production. Biodiversity must be maintained and the energy balance of the whole biomass system must be positive. No genetically modified plants can be included in biomass production. Hydropower must not be used on a massive and destructive scale. Existing hydropower systems will be reviewed and assessed for their environmental impact. Any additional hydropower plans would promote small- and medium-scale hydro schemes on a case-specific basis. Reforestation programmes must be put in place to counter any clearances made for hydropower. Primary forest must not be sacrificed for such schemes. Photovoltaic production can involve problematic materials. Fuel cells are only emission-free when powered by clean hydrogen not acquired from fossil fuels or nuclear power.

As the saying goes, “There is no such thing as a free lunch”, but any impacts must be as minimal as possible in the total system.

This report clearly illustrates that a combination of renewable sources and energy efficient technologies can provide a solution that meets the above criteria.

The costs of such a system are lower than conventional sources when the total internal and external costs are factored, and they are becoming more price-competitive as they gain a greater per-

6. “At the most fundamental level, the principles of equity and equality must be integrated into all aspects of sustainable development. Sustainable development is in essence a participatory process, and problems of inequality, financial insecurity, etc. will tend to hinder the participation of some sectors of the community. A major goal of sustainable development must therefore be to tackle these problems.” Source: Action Towards Local Sustainability (UK).

centage of the energy market, as production prices drop considerably with increased mass production[7]. A truly renewable energy system will only become a reality if we begin to make moves in that direction now.

2.2) General Framework

Why did we select Japan as the subject for this study? The answer lies in the challenge: if it is possible to achieve a 100% renewable energy system in Japan using today's best available technology, it would be possible to transfer and adapt the results to many other locations even to cover the whole globe.

Japan, home of and signatory to the Kyoto Protocol on climate change, has been considered energy-poor with respect to fossil fuels and has become heavily dependent on energy imports. It has consequently adopted an extensive nuclear program, which is increasingly providing more problems than solutions. Despite its history of rapid industrial change, Japan does not have great preconditions for a rapid change to renewable energy, as it is highly industrialised and densely populated with a comparatively high-energy demand. Available land and water potential is also not well placed. Japan is a relatively remote island group with few options for energy exchange with other nations. However Japan is well placed for geothermal, wind and solar energy, which are also available in most parts of world. In rising to and meeting the challenge of a 100% renewable energy system for Japan, the study proves the viability of a truly sustainable energy system, which can be transferred to other regions.

A number of factors were identified as preconditions for the report. The first was that the study should fit into the Japanese system as it is, without any major changes in lifestyles. This entailed modelling an energy demand structure without proposing any changes in living standards. No predictions for economic growth or decreases are considered either. It was also assumed that the current transport infrastructure and traffic densities would not be altered to accommodate the energy system. In other words, the goal of the project was to show that a sustainable, renewable and efficient energy system is theoretically able to supply Japan's current needs. Conservative estimates were made in all areas of the study.

The power supply of Japan is presented in the six scenarios introduced here in this study. The electrical system of this innovative energy demand and supply system is simulated with a high temporal and spatial resolution, with the SimREN computer model using real weather conditions.

7. This is shown in Detail for Germany in the final Report of the Enquete Commission of the German Parliament „Sustainable Energy Supply against the Background of Globalization and Liberalisation“ (Source: Enquete Commission (2002)).

This is done to firstly optimise that system, and also to increase the plausibility of the energy scenarios described in this study. Three main scenarios are presented, ranging from a 50% domestic supply of energy from renewable sources to 75% and a 100% domestic supply, with variations on these three scenarios incorporating a predicted decline in the Japanese population from 127 million in 1999 to 100 million by the year 2050.

The systems described here provide a framework for a debate about the restructuring of the Japanese energy economy. However restructuring with renewable energy does not need to be limited to the ideas described in this report. Other systems that can supply Japan with renewable energy are also possible.

This study does not attempt to answer two key questions: How quickly can such a system be implemented and how much will this system cost? Both questions are often examined in energy scenarios. The majority of the project team were in agreement that answering these questions would go well beyond the scope of this study, which is meant to be a first step towards quantifying the resource. Giving answers to these questions would require an additional study.

To demonstrate the possibility of a solar energy supply for Japan, it is not necessary to specify the costs and the timeframe such a development will require. The energy system described in the ERJ Report entails a long process of developing and restructuring the present-day system according to future needs. The technological feasibility of the presented system can be proven based on present-day knowledge, applying the simulation system usedfor the first time in this study . Furthermore the uncertainty of future cost estimations and of introductory scenario studies would distract the discussion from the results of the study[8]. Namely that Japan is an energy rich country and that it can supply itself fully based on renewable sources.

However to give a sense of the order of magnitude for the time frame, existing scenarios and historical information from other regions would suggest that within 20 years at least a 30% increase in efficiency and at least a 30% provision by renewables is possible, but this is highly dependent on the availability of resources, the starting point and the political measures in the country in question.

From the basic desire to illustrate the feasibility of a ‘100% sustainable region’, Greenpeace International and Greenpeace Japan commissioned a scientific collaboration with institutions in Europe and Japan. The contributors included EUTech (Germany), ISEP (Japan), Wuppertal Institute (Germany) and ISUSI (Germany) with an international team. Close co-operation between the groups was ensured at all times.

8. More about this in: “Energy Rich Japan - Aspects of Costs and Timeframes“. available under www.energyrichjapan.info

The main emphasis of the work of EUTech lay on the analysis of efficient energy technologies especially in the industrial sector. ISEP concentrated on supplying data on Japan (e.g. the potential of renewable energies, data on electricity demand and weather data) and on formulating political goals and accompanying the development of the supply and demand models critically. The Wuppertal Institute's main emphasis lay on formulating the demand model. The international team of ISUSI provided the supply model, developed a Japanese version of the computer program SimREN, realised the simulation and co-ordinated the scientific work.

All meetings where done in Japan and the team worked together on all parts of the study. Such a study cannot always be realised without differences of opinion. Insofar as they could not be clarified in discussion, I accept the responsibility.

Prominent scientists from Japan and from Europe were consulted as independent external reviewers during the preparation of this report: Dr. Robert Gross (Imperial College UK), Dr. Jorgen Stig Norgard (Technical University of Denmark), Dr. Yasuhiro Murota (Shonan Econometrics), Dr. Hidetoshi Nakagami (Jukankyo Research Institute), Dr. Naoto Sagawa (Jukankyo Research Institute), Dr. Hermann Scheer (Eurosolar and alternative Nobelprize winner) and Dr. Jörg Schindler (L-B Systemtechnik).

I wish to thank them for their work, their criticism, contributions and support towards publishing this study. We have included the in some points contradictory suggestions in the study as far as possible. I would like to thank Jörg Schindler for his contribution to the hydrogen part of the report. Many thanks to Hermann Scheer for the support the "World Council for renewable Energies" (WCRE) gave the report during publication.

Lastly I wish to thank Greenpeace International, Greenpeace Japan and especially Lynn Goldsworthy for the support with this study, without which this report would never have been realised.

How to achieve to a sustainable energy system is the question I hope we have addressed with this study. What we need now is the desire and will to make it happen.

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