WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE

European Climate Change Policy Beyond 2012

World Energy Council 2009

Promoting sustainable energy for the greatest benefit of all

Annex E: Alternative Technologies

Annex E 1: Albedo Control Systems (ACS)

The rapid and continuous increase in the concentration of GHGs and the weaknesses in policies and technical instruments to fight the increase made it necessary to find environmentally friendly, technically simple and cheap solutions to be applied in countries with limited economic resources to control the global average temperature increase.

An effective solution to reduce global warming and counteract the effect of emissions of GHGs in terms of global temperature could be the control of Earth's albedo (ACS) by implementing "white-reflecting" surfaces with a high reflection coefficient. Reflecting surfaces reduce absorbed energy thus increasing the solar energy reflected in to space and so reducing the amount of energy contributing to the Earth's warming.

Quantification of reflecting surface effectiveness has been accomplished through an innovative and patented mathematical equation, based on an energy balance between sky, atmosphere and earth surface. The correlation between the temperature reduction and the GHG decrease in the atmosphere has been also calculated. The effectiveness of reflective surfaces is closely related to latitude and meteorological and morphological characteristics of the installation area. Each m^2 of high albedo (90%) surface compensates for an amount of CO_2-eq introduced in the atmosphere varying from 45 to 62 kg.

Table E-1

Comparison of avoided CO_2-eq emission costs between different renewable sources and the white reflecting technology

Technology	Avoided CO_2-eq costs
	c€/KgCO_2-eq
Photovoltaic amorphous silicon	74.8
Photovoltaic multicrystalline silicon	83.0
Photovoltaic monocrystalline silicon	98.8
Thermal solar (flat collector)	14.5
Wind generator	3.9
Hydroelectrical	4.3
Albedo control	4.4

The reflective surfaces can be created both on land and sea; both artificial and natural surfaces can be used (roofs of houses, sport facilities and industrial plants, roads, pedestrian areas, city squares, car parking lots, gardens, parks, etc). Alternatively, trees, shrubs or flowers with appropriate colour characteristics (high average reflection coefficients) can also be utilised. On land, reflective surfaces can be obtained by laying paints, films, plates or any type of coating with a high reflection coefficient. Other cheaper materials, such calcium carbonate powder, grain patterns for flower beds or gardens or lime hydrate could be used in many areas. Reflective surfaces could be also implemented by restoring disused salt evaporation ponds. A procedure to control surface albedo based on high definition satellite differential spectrophotometry has been developed and standardised.

In Table E-1, a comparison among ACS and renewable energy sources is shown, based on the cost required to avoid the same amount of introduced CO_2-eq. As far as renewable energy power plants are concerned, the cost of GHG emissions reduction has been evaluated as the ratio of the difference in production cost of ACS as compared with the most successful traditional technology in reducing emissions by the same amount, for the generation of an electrical or thermal energy unit. The reference price for white reflecting surfaces is the cost of paint/film, marked up to include the labour cost necessary to produce and efficiently operate the surfaces (Patent).

Territories in the equatorial belt (intertropical zones), dry and low cloud areas, seas and oceans are favoured locations to implement the proposed solution due to high insulation and low cloud coverage.

Interesting economic opportunities could arise for underdeveloped and developing countries in such areas. If the global warming reduction effectiveness of reflecting surfaces was internationally acknowledged, these countries could make a greater contribution to the worldwide efforts towards a better climate.

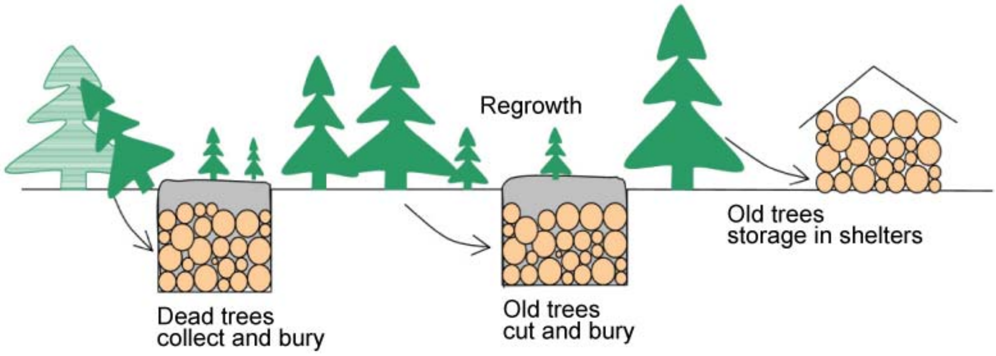
Annex E 2: Pipe§net system

“Pipe§net” is an innovative freight transport system for loads up to 50 Kg (volume 200-400 litres), constituted by a network of vacuum-sealed pipes divided into sections, where goods-carrying capsules are moved by electric linear motors (LSM) in very low-friction conditions and at variable speeds. In comparison to other systems, Pipe§net focuses on small volume freight, avoiding many of the critical issues innovative systems meet in their development. With Pipe§net, small volume freight is conveyed at high speeds in order to maintain a transport capability higher than traditional systems. Pipe§net’s main features are: high transport capability (through high speed and high linefill rate); traffic relief potential; low energy consumption (LSM recovers part of the acceleration energy); low environmental impact both from air and noise emissions; fast delivery of goods; seamless and affordable connections by flexible integration into existing transport facilities; intermodal/comodal integration with traditional transport systems to increase the quantity and quality of the solutions for the optimisation of

Figure E-1

Carbon sequestration via wood burial

Source: Ning Zeng, 2008



logistic supply chains; potential for widespread distribution and door-to-door features; reduction in morbidity and mortality on the streets and goods-on-demand features (the system is oriented towards the final customer).

A distinguishing feature of Pipe§net is its application flexibility, in particular when it is associated multimodally (through inter and comodal services) with traditional transport systems: Pipe§net can be applied to urban scenarios with a high density of logistic service needs, thanks to its low environmental impact, its traffic relief capacity and the high rate of freight delivery; it can connect several strategic areas of one or more industrial zones and reach the artistically relevant city centres due to the small infrastructural size and its building integration with pre-existent facilities (such as railways, underground, bridges, etc.). Pipe§net can connect two distribution points of one logistics operator with a high traffic density (business to business connection); the multi-modal potential of Pipe§net also allows for functional integration with the logistic services provided by road and rail transportation; through intermodal interfacing the last link of the supply chain can be covered, while specific comodal strategies satisfy the logistic needs in any scenario (Pipenet 2008).

Annex E 3: Carbon sequestration via wood burial

A simple method for carbon sequestration consists of storing wood in such a way as to prevent the emission of GHGs in to the atmosphere while allowing it to rot and simultaneously planting new trees. Harvested wood can be buried in trenches or stowed away in above-ground shelters. Since trees are very efficient in collecting CO_2 from the atmosphere when they grow, this method is a simple method of absorbing CO_2 from the atmosphere. It is estimated that a sustainable long-term carbon sequestration potential for wood burial is 10 ± 5 GtC per year, costs are estimated to be \$14/tCO_2. Critical to the proper implementation of this method, however, is an effective monitoring and reporting system.

The technique described here has a number of benefits. Most importantly, it is low-tech and safe, allowing it to be implemented globally on a large-scale, delivering substantial reductions.

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