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# LOW CARBON JOBS FOR EUROPE

Current Opportunities and Future Prospects



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Author: Meera Ghani-Eneland, WWF, with contributions from Michael Renner  
and Ambika Chawla, Worldwatch Institute

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# INTRODUCTION

Europe, along with the rest of the world, finds itself at a critical confluence of climate crisis and economic crisis. In its climate and energy package adopted in December 2008, the European Union set a 2020 target of cutting CO<sub>2</sub> emissions by 20 per cent below its 1990 emission levels (rising to 30% if other industrialised countries join the effort) and increasing the share of renewables of all primary energy consumed by 20 percent.

Carbon pricing, via the EU's Emissions Trading Scheme (EU-ETS), is a central component of the EU's climate policies. A series of Directives and regulations are also important drivers, including the Directive on the Promotion of Electricity Produced from Renewable Energy Sources (2001), replaced by the Directive on the Promotion of the Use of Energy from Renewable Sources (2008); the Biofuels Directive (2003); the Directive on the Energy Performance of Buildings (2003, now being revised); the Eco-design Directive (2005); and the Regulation on CO<sub>2</sub> Emissions of Passenger Cars.

However, the EU27 has already reduced its emissions by almost 8% by 2005 since 1990 and most of the remaining 12% GHG emissions reductions agreed until 2020 could be met by project-based offsets in developing countries via the Clean Development Mechanism (CDM). In essence, from now on, there is danger that no more than 4-5 % of GHG emissions reductions will occur within European boundaries. In this respect, new and additional policies domestically to target energy efficiency in all sectors of economy in particular are needed to boost the target to at least a 30% cut in GHG emissions in Copenhagen.

## A GREEN STIMULUS?

The economic crisis renders implementation of the EU's climate and energy package more difficult.<sup>1</sup> An array of stimulus measures has been passed to inject huge sums of money into the economy and overcome the credit crunch. Conventional efforts to reinvigorate the economy entail the risk of a carbon-intensive recovery that will cement the technologies and structures that have led the world to the brink of climate catastrophe. But a sufficiently green stimulus can reinforce ongoing efforts to transform the economy and spawn large numbers of additional green jobs.

According to an HSBC Global Research analysis of €2.2 trillion worth of global stimulus packages worldwide, close to €300 billion are germane to climate policy objectives. Europe accounts for €42 billion of this, or about 13 percent of the global total. (See Table 1)<sup>2</sup>

European stimulus packages provide a boost to Carbon Capture and Storage (CCS) research and low-carbon vehicles and, to some extent, energy efficiency of buildings. The European Commission's Economic Recovery Plan—to be finalized in June 2009 once the European Parliament signs off—includes, among other provisions, promising initiatives on green cars (€5 billion), energy-efficient buildings (€1 billion for R&D), and “factories of the future” (€1.2 billion for R&D). A substantial portion of the Commission's funds—close to 60 percent—are “green”.<sup>3</sup>

Table 1. Green Dimensions of European Stimulus Funds

	Total	Green Funds		RE	CCS	Bldg	Veh	Rail	Grid	W/W
	€ Billion <sup>4</sup>	€ Billion	%	€ Billion						
EU	30.0	17.6	58.7	0.5	9.7	2.2	1.5	--	3.8	--
Germany	81.0	10.7	13.2	--	--	8.0	0.5	2.2	--	--
France	26.0	5.5	21.2	0.7	--	0.6	--	1.0	3.2	--
UK	23.5	1.6	6.9	--	--	0.2	1.1	0.3	--	0.02
Italy	80.0	1.0	1.3	--	--	--	--	1.0	--	--
Spain	11.0	0.6	5.8	--	--	--	--	--	--	0.6
Other EU States	238.5	4.8	2.0	1.5	--	0.3	3.0	--	--	--
Total EU	490.1	41.9	8.5	2.7	9.7	11.4	6.1	4.5	7.0	0.7
Rest of World	1,670.5	295.1	16.2	26.7	5.9	40.3	6.2	89.6	63.9	62.4
World	2,160.6	336.9	15.6	29.4	15.5	51.6	12.3	94.1	70.9	63.1

RE Renewable Energy  
 CCS Carbon Capture and Storage, and other low-carbon technologies  
 Bldg Building Energy Efficiency  
 Veh Low-Carbon Vehicles  
 W/W Water and Waste Management

Sums may not add up due to rounding

Source: HSBC Global Research “A Climate for Recovery”.

However, the share of combined Commission and national member state funds comes to less than 9 percent, and is thus arguably not nearly green enough, even as traditional, carbon-intensive programmes receive substantial support. (For instance, some €210 billion is allocated worldwide to road building.<sup>5</sup>) There are wide divergences in national stimulus packages, with France and Germany putting relatively more emphasis on green measures than Italy, Poland, Spain, the United Kingdom, Sweden, and Greece.<sup>6</sup>

The European Commission has also announced some €105 billion in cohesion funds to be spent in 2007-2013 to create “green jobs and growth”—a substantial portion of which will go to Eastern Europe. (Bulgaria and Romania are the countries with the largest share of cohesion funds earmarked for environmental projects—45 and 42 percent, respectively.<sup>7</sup>) While these are not new funds but rather concern dispersal of previously committed sums, they are triple the amount allocated for similar purposes during 2000-2006. Specifically, some €48 billion is aimed at climate objectives (€23 billion for railways, €6 billion for public transport, €4.8 billion for renewable energy, and €4.2 billion for energy efficiency).<sup>8</sup>

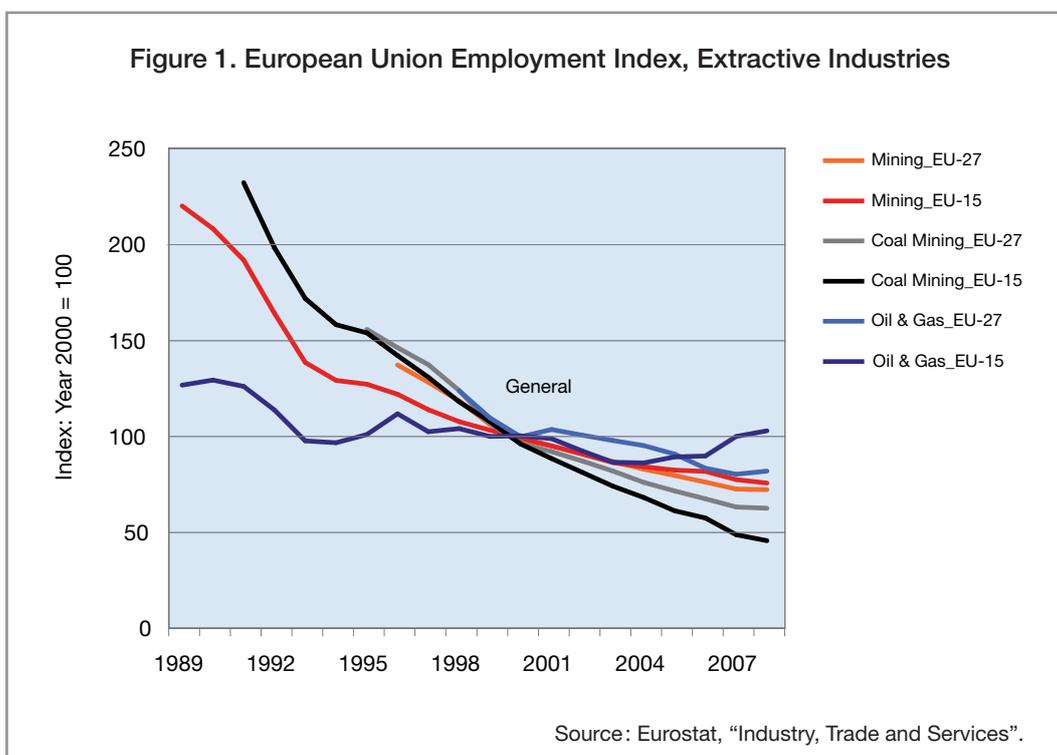
## JOB GAINS AND LOSSES

Whether through stimulus spending or other programmes, climate-related policies can create large numbers of new green jobs (and make existing ones greener). Evidence to date suggests that green jobs span a wide array of occupations, skill-levels, and salaries, offering opportunities for a broad swathe of the workforce.

But it is also true that job loss (and job shifts) will occur in energy extraction and refining, the power sector, and in energy-intensive industries like steel, aluminum, paper, and cement. The auto industry and aviation will also be affected. Out of about 130 million jobs in 2006 in the EU-27 countries, just 733,000 were in mining operations, and 1.6 million were in electricity, gas, and water supply. Oil refining employs about 100,000 people, the cement industry about 53,000, and the iron and steel industry about 350,000. The power sector and the auto manufacturing industry weigh more heavily, with some 2 million jobs each. The construction sector, which is set to benefit from stimulus packages and climate policies, provides employment for 13 million people.<sup>9</sup>

Extractive industry jobs have been on the decline for many years in the EU-15 and EU-27.<sup>10</sup> (See Figure 1) This job loss is largely due to growing automation, rising labor productivity, and trade dynamics, rather than an outcome of climate protection policies.

What counts is that the economy-wide losses from the traditional energy-intensive/high-carbon sectors are substantially lower than the gains of new jobs through clean technologies. However, it should be an imperative that a transition must be just to those employees who are likely to be affected negatively.



Job gains are likely to far outweigh job losses that will occur in a shift to a green economy. (See Box 1) Environmentally benign alternatives tend to offer more jobs per unit of investment or unit of industrial capacity. A review of about a dozen studies in the United States and Europe concluded that renewable energy projects generate a multiple of the number of jobs generated in fossil fuel projects per megawatt of capacity.<sup>11</sup>

Nonetheless, the losses are real for each individual affected, as well as for families and communities. This is particularly the case in areas where there are high concentrations of vulnerable industries and a lack of economic diversification. The implication is that there is a clear need for pro-active policies that assist in this transition by way of retraining, skill-building, income support and social protections. Long demanded by trade unions, such fair transition policies are yet to be implemented.

## JOB GAINS AND LOSSES – EVIDENCE FROM FRANCE

WWF France's study of the impacts of cutting CO<sub>2</sub> by 30 percent by 2020 affirms what other studies have also shown, namely that the job gains outnumber the job losses. It concludes that some 316,000 renewables jobs and 564,000 energy efficiency jobs will be created in France, while 138,000 jobs in the conventional energy sector and 107,000 in the auto industry could be lost. Redirected spending from energy savings could induce an additional 48,000 jobs if oil prices are at \$100 per barrel (but 467,000 jobs at \$150 per barrel), for a net gain of 684,000 jobs.<sup>12</sup>

Some Trade unions, scientists, business, NGOs and others believe that carbon capture and storage (CCS) technologies are a necessary component of low carbon development globally. If workable CCS is also a means to ensure a continued future for fossil fuel-fired power plants. A Prognos AG study financed by German utility company RWE (one of Europe's biggest users of coal) claims that CCS in Germany could create 45,000 to 66,000 jobs in the period 2016-2030. Still, many technological issues have not been resolved, costs are high, and there are still many open questions as regards to location of safe CO<sub>2</sub> reservoirs. Meanwhile, CCS suffers from energy penalties compared to unabated fossil fuel power stations and entails other environmental costs. However, if conducted carefully and with the best available technologies some of the negative impacts of CCS may be solvable such as air pollution, and high water use. At the same time and similar to all low-carbon climate solutions building a CCS infrastructure of the necessary scale would need to begin almost immediately in light of the urgency of climate action. Most low-carbon scenarios project that a speedy decarbonisation besides CCS for coal is not possible without CCS also for high carbon industrial sectors such as steel and cement. CCS for sustainably produced biomass is another very promising option to shift to carbon-negative emissions rather than relying on CCS for fossil fuels alone.

Overall, there is little evidence for a broad-brush assertion that climate policy is a job killer—much of the European job losses in recent years have been due to rising automation, restructuring, and outsourcing. Of course, much depends on the conditions under which the transition to a more climate-compatible economy is taking place. The pace of change is a critical factor, as is the question to what extent governments will design timely measures to smooth the process. In fact, far from undermining competitiveness, climate policies can position European business at the technological cutting edge, thus securing rather than undermining and outsourcing employment.

## GREEN MARKET POTENTIAL

The relationship between environment and employment is evolving, from an initial focus on pollution control and waste management toward activities that transform the economy and avoid environmental damage. The EU environmental industry, broadly defined, was estimated to employ some 3.4 million people, in full-time job equivalents, in 2005. That is more jobs than those found in the auto or chemical industry. Some 2.35 million of these jobs were in the pollution management sector.<sup>13</sup> In 2006, Germany alone was estimated to have 1.8 million environment-related jobs. (See Box 2)

Even before the climate crisis became the overriding concern, it was clear that a range of measures designed to limit environmental damage had, on balance, positive job impacts. This was the conclusion of a detailed 2007 study that projected a 1.5 percent overall increase in EU-25 employment over the next 10-20 years resulting from CO<sub>2</sub> emissions reductions.<sup>14</sup>

### ENVIRONMENT-RELATED EMPLOYMENT IN GERMANY, 2006

Germany had at least 1.8 million environment-related jobs in 2006. This represented 4.5 percent of all gainful employment in 2006, up from 3.8 percent in 2004. The government believes that reaching its climate protection goals will require annual investments of about €30 billion, which could lead to the creation of 800,000 additional jobs by 2030. Shifting subsidies for coal into building retrofits would offer a net gain of 30,000 jobs.<sup>15</sup>

Sector	Jobs
Investments and Equipment for environmental protection*	350,000
Environmental Services and Personnel of which:	1,132,400
• Organic agriculture	41,600
• Organic food retailing	160,000
• Energy services (efficiency contracting, marketing of renewables and combined heat and power, etc.)	49,000
• Communications and transport services (incl. rail services, car-sharing, etc.)	70,000
• Public administration	63,000
Export of Environmental Goods	49,000
Renewable Sources of Energy	235,600
<b>Total</b>	<b>1,767,000</b>

\*Principally for pollution control (waste management, air and water quality, and noise reduction).

Global markets for environmental goods and services will likely see continued strong growth. They are projected to grow from about €950 billion today to more than €2,000 billion

in 2020. Employment will also continue to grow rapidly in renewables, energy efficiency, and transport alternatives.<sup>16</sup> (See Table 2)

**Table 2. World Market Estimates for Sustainable Resource Management**

	World Market Estimate		Job Growth	
	Year	€ Billion	Period	Percent
Renewable Energy	2005	100	2004-06	30
	2020	280	2007-09	22
Energy Efficiency	2005	450	2004-06	15
	2020	900	2007-09	16
Sustainable Mobility	2005	180	2004-06	9
	2020	350	2007-09	18
Solid Waste Management and Recycling	2005	30	2004-06	9
	2020	46	2007-09	7
Sustainable Water Management	2005	190	2004-06	8
	2020	480	2007-09	12

Source: Green Inc., Kate Galbraith, "In Europe, Wind and Solar Feel Financial Crisis".

European employment in climate-friendly businesses will be influenced not only by EU policy, but also by the extent to which other countries will adopt strong climate policies and the degree to which European firms are able to service these emerging green markets. An assessment by the German government suggests that EU countries currently control a substantial portion of global sales of many critical efficiency technologies: industrial processes (71 percent), water-use efficiency (66), eco-design for materials efficiency (64), electrical appliances (55), building technologies (53), propulsion technologies and emission

controls (51 percent), and vehicle technology and design (42).<sup>17</sup>

This report gathers evidence of already-existing green jobs and assessments of potential job growth as the EU pursues its 2020 target. It marshals data and information from a range of sources, derived through a variety of methods. It reports on findings from input-output studies, and sector-specific surveys and projections carried out by EU agencies, national governments, NGOs, and industry associations. Further, it presents some computations based on benchmarks and criteria set by the author.

# SHIFTING FROM FOSSIL FUELS TO RENEWABLE ENERGY

The growth of the renewable energy sector has been rapid, but there is concern that the credit crunch could interrupt this trend. In the solar sector, banks are becoming more selective, take longer to finance projects, and are reducing the portion of funding they cover. In the wind industry, there is not yet any solid evidence of a slowdown. Bank lending is tight, but an increase in the interest rate premiums charged has been offset by a reduction in the general level of interest rates due to the overall economic slowdown.<sup>18</sup>

To date, a small number of countries account for the bulk of renewables installations worldwide.<sup>19</sup> (See Table 3.) European countries have been in the forefront, and a number of studies suggest

substantial job potential.<sup>20</sup> A modeling exercise supported by the EU found that under current policies, there could be a net gain of 950,000 direct and indirect full-time equivalent (FTE) jobs by 2010 and 1.4 million by 2020. Under an “Advanced Renewable Strategy,” there could be **1.7 million** net jobs by 2010 and **2.5 million** by 2020. About 60–70 percent of the jobs would be in renewables industries (primarily biofuels and biomass processing and wind power), the remainder in agriculture.<sup>21</sup> Similarly, the European Renewable Energy Council (EREC) argues that by raising the share of renewable energy to 20 percent of the EU’s energy consumption by 2020, the number of green jobs could rise to more than 2 million.<sup>22</sup>

Table 3. Leading Countries in Renewable Energy Development

Energy Source	Countries
Small Hydropower	China, Japan, United States, Italy, Brazil
Wind Power	Germany, Spain, United States, China, India, Denmark
Biomass Power	United States, Brazil, Philippines, Germany/Sweden/ Finland/Hungary
Geothermal Power	United States, Philippines, Mexico, Indonesia/Italy
Solar Photovoltaic Power	Germany, Japan, United States, Spain, Italy (installations); China, Japan, Germany, Taiwan (production)
Solar Thermal Electric	United States, Spain
Solar Hot Water	China, Turkey, Japan, Germany, Israel
Ethanol	Brazil/United States, China, Spain/India
Biodiesel	Germany, France, Italy, United States, Czech Republic

Source: European Commission, “Meeting the Targets & Putting Renewables to Work. Overview Report”, MITRE-Monitoring & Modelling Initiative on the Targets for Renewable Energy.

Developments in international energy markets and prices, as well as the evolution of international climate Policy, will have a major impact. The requirements contained in the EU's climate package will stimulate technological change and encourage innovation of products and processes within the EU. This is likely to result in a competitive advantage for Member States, increased market share, turnover, and added employment. Additional job projections can be found in the discussion of individual renewable energy sources below.

Germany and Spain are leading forces in Europe. In Germany, the number of renewables jobs jumped from 56,600 in 1998 to almost 250,000 in 2007 and 278,000 in 2008.<sup>23</sup> Roland Berger business consultants project that Germany may have 400,000 to 500,000 people employed in renewables by 2020 and 710,000 by 2030.<sup>24</sup> In 2007, a trade union study found that Spain's renewables industry employed 89,000 workers directly and another estimated 99,000 indirectly, for a total of 188,000. Renewables firms are spread evenly throughout different regions of Spain, though with some concentration in already industrialized regions, including Madrid, Catalonia, Valencia, Basque country, and Andalusia.<sup>25</sup>

## WIND POWER

Global wind power capacity reached 120,800 megawatts (MW) by the end of 2008, 36 percent more than in 2007 and more than 20 times as much as in 1995.<sup>26</sup> In 2007, the European continent accounted for 66 percent of currently installed capacity.<sup>27</sup> Europe has so far dominated the global wind power sector, both in turbine manufacturing and installations (though the United States and China now saw their installations surge in 2008). European wind turbine manufacturers controlled about 90 percent of worldwide wind turbine sales in 1997; they still have an 80 percent market share today.<sup>28</sup> Danish manufacturers have supplied almost 40 percent of the cumulative generating capacity installed worldwide, with Vestas being the dominant company.<sup>29</sup>

Germany had an estimated 85,000 wind energy jobs in 2008. It has for a number of years had the most wind-related employment in the world—though the United States has now apparently drawn even thanks to record installations in 2008.<sup>30</sup> In 2007, German wind companies exported 70 percent of their production and accounted for one out of three wind turbines installed worldwide.<sup>31</sup> Denmark's governmental support has grown unsteady in recent years. Domestic employment, which grew from less than 10,000 jobs in 1996 to about 21,000 in 2002, has since stagnated.<sup>32</sup> Spain employs more than 20,000 people in wind directly and more than 40,000 people including indirect jobs.<sup>33</sup>

Eastern Europe has been slow to embrace wind energy, but this is changing now. Wind power increased 150 percent in 2008 in the Czech Republic.<sup>34</sup> Poland's wind capacity grew 71 percent in 2008. Bulgaria has a goal of 220 MW wind capacity by 2012, up from 16.5 MW today. Spain's Iberdrola Renewables is building projects in Poland, Romania, Hungary, and Estonia.<sup>35</sup>

Wind energy development has helped revitalize regions that had suffered from economic decline, such as northwestern Denmark, Schleswig-Holstein in northern Germany, or Navarra in Spain. Denmark has experienced a shift from shipbuilding to wind energy.<sup>36</sup> Wind development can provide similar benefits in other European countries with areas that suffer from deindustrialization or outsourcing. Policy support—in the form of feed-in tariffs, domestic content provisions, or other measures—is critical.

Table 4. Direct Wind Energy Industry Employment in Europe, 2007

	Jobs	Notes
Germany	38,000	84,300, incl. indirect jobs in 2007; 85,100 in 2008.
Denmark	23,500	8.7% growth over 2006.
Spain	20,500	37,730, incl. indirect jobs in 2007; surpassed 40,000 in 2008 and might reach 58,800 by 2012.
France	7,000	Expects up to 16,000 jobs by 2012.
United Kingdom	4,000	Possibly as many as 4,800 jobs.
Italy	2,500	4,430 in 2008 (15,000 including indirect jobs). Could reach a total of 66,000 jobs by 2020.
Belgium	2,000	
Netherlands	2,000	
Sweden	2,000	
Greece	1,800	
Ireland	1,500	
Finland	800	
Poland	800	
Portugal	800	3,000 additional jobs from 2009 on.
Austria	700	
Bulgaria	100	
Czech Republic	100	
Hungary	100	
Rest of EU	400	
EU Total	108,600	

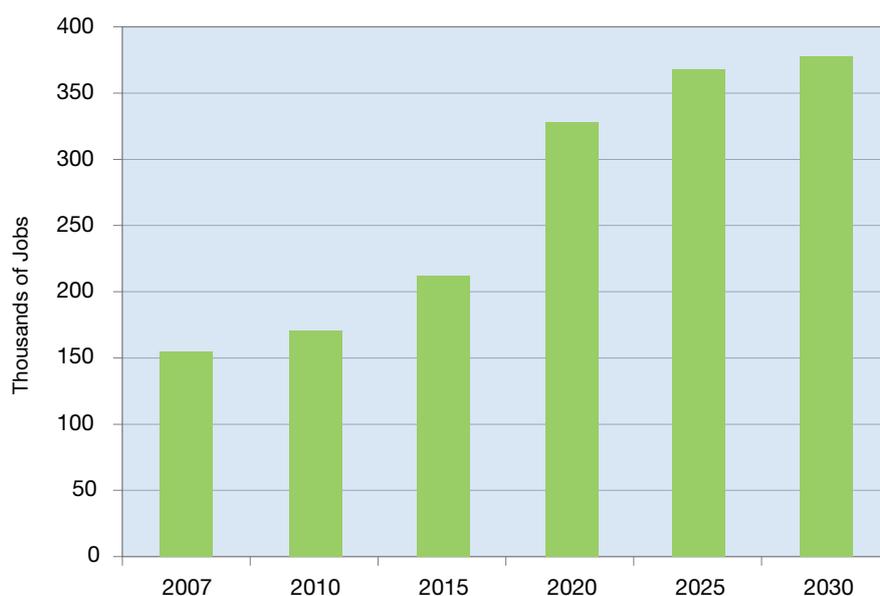
Source: Worldwatch Institute, Vital Signs 2007-2008.

Worldwide, the Global Wind Energy Council puts wind employment at more than 400,000 jobs in 2008 (including jobs in supplier industries).<sup>37</sup> That's up from 329,000 people worldwide in 2007. The EU accounted for almost half the 2007 total, or about 154,000. This includes 108,600 direct jobs (see Table 4) and 42,700 indirect jobs; an estimated 2,800 additional jobs relate to the higher labor inputs needed at offshore installations. About 64,000 positions are found in wind turbine and component manufacturing, more than 17,000 in wind farm (site) development, almost 12,000 in installation, operation, and maintenance, about 10,000 at utilities, with the remainder accounted for in R&D, universities, consultants,

and financial positions.<sup>38</sup> Taking into account 2008 job estimates for Germany and Spain, the European total is now likely to have reached at least 160,000. (See Table 8 later in this paper)

The European Wind Energy Association (EWEA) projects that by 2020, there will be 180 GW of capacity installed, and 300 GW by 2030. Based on these projections, the organization believes that wind employment in the EU will rise to **329,000** and **377,000**, respectively. (See Figure 2) These projections are based on 15.1 jobs per new MW (manufacturing) and 0.4 jobs per cumulative MW (operations and maintenance), declining gradually (with rising labor productivity) to 11 and 0.29 jobs, respectively, by 2030.<sup>39</sup>

Figure 2. EU Wind Power Employment, with Projections, 2007–2030



Source: EPIA and Greenpeace International, Solar Generation V - 2008 (Brussels and Amsterdam, 2008), p. 32.

## SOLAR PHOTOVOLTAICS

Electricity generation from solar PV cells is one of a range of promising solar technologies. Global production of PV cells rose to a record 3,733 MW in 2007—a more than 20-fold increase over 1998.<sup>40</sup> Its output soaring, China captured 29 percent of global production, overtaking Japan and Germany (with 22 and 20 percent, respectively). Europe as a whole has a 25 percent share. Broken down by companies, the top 9 producers accounted for half of global production.<sup>41</sup>

Annual PV installations reached 2,392 MW in 2007, up from 278 in 2000 and 78 in 1995. Germany continues to dominate the installation market, with almost half the global total. Its current annual installation rate of 1,100 MW could more than double by 2012. Germany was followed by Spain with 341 MW installed in 2007, Japan (210 MW) and the United States (205). Italy added 50 MW and France 12.8 MW.<sup>42</sup>

The worldwide cumulative installed capacity reached 9.2 GW in 2007, up from 1.4 in 2000 and 0.5 in 1994. Europe's cumulative capacity ran to 4.7 GW in 2007. More than 80 percent—some 3.8 GW—was in Germany. Spain had a cumulative 655 MW installed by end of 2007, with another 1,000 MW to be installed in 2008. Italy had a comparatively small 100 MW in 2007 (but expected to double by the end of 2008) and France had about 36 MW.<sup>43</sup>

Europe's share of cumulative capacity, currently at slightly more than half the world's total, is projected to decline to 40 percent by 2020 and 20 percent by 2030, as other regions of the world increase their installations. In terms of annual installments, Europe's share is expected to fall from 72 percent in 2007 to 29 percent in 2020 and 10 percent in 2030.<sup>44</sup> (See Table 5)

Table 5. Solar PV Installation Projections for EU-27 Countries, in Gigawatt, 2007-2030

Installations	2007	2010	2020	2030
Annual	1.7	3.6	16	28
Cumulative	4.6	13.5	100	360

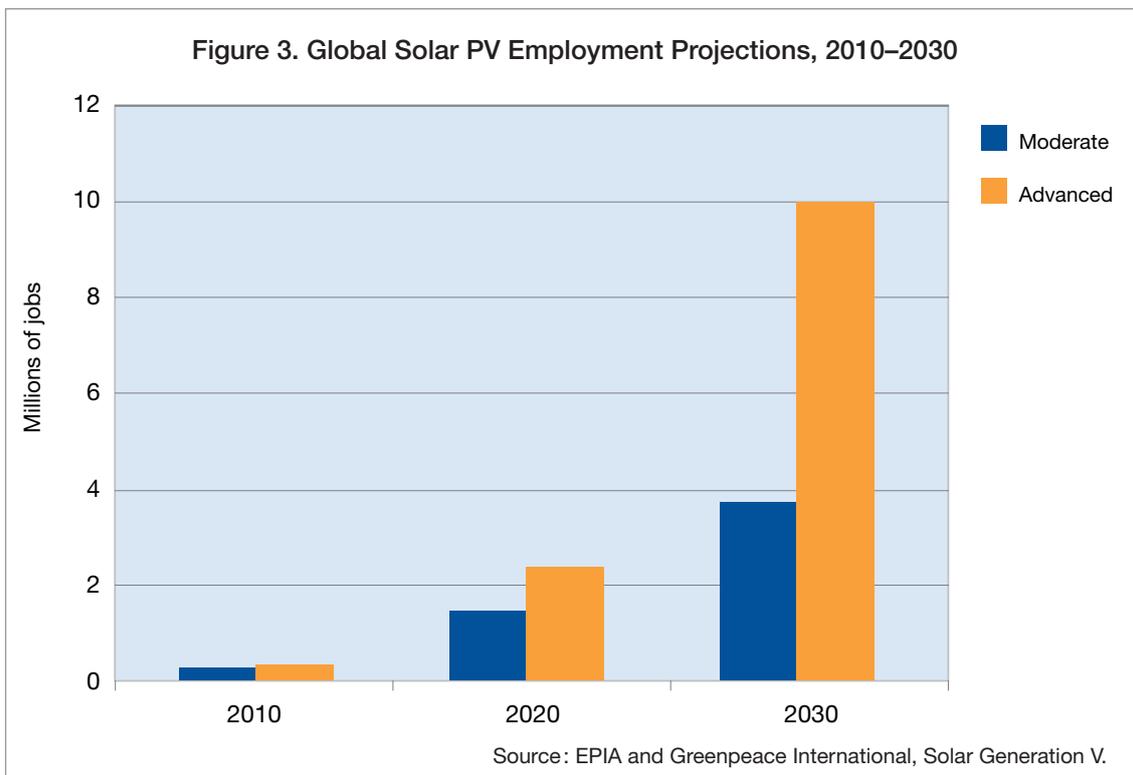
Source: O'Sullivan et al, op. cit. note 25.

Table 6. Solar PV-related Employment, 2007

European Countries	Employment	Selected Others	Employment
Germany	42,000	China	82,800
Spain	26,800	United States	50,000
France <sup>1</sup>	3,500	South Korea	1,600
Italy	1,700		

<sup>1</sup>By 2012, 13,000 direct and 6,000 indirect jobs projected.

Source: EPIA and Greenpeace International, Solar Generation V.



*Solar Generation V*, a joint study by European Photovoltaics Industry Association (EPIA) and Greenpeace International, put current global PV employment at 208,000.<sup>45</sup> (See Table 6) Findings from Germany suggest that this 2007 figure may already understate employment, given continued rapid expansion. According to the German environment ministry, German PV-related jobs surged from 38,600 in 2007 (lower than the figure in Table 6) to 57,000 in 2008.<sup>46</sup>

The *Solar Generation V* report also projects that as many as **10 million jobs** will be created in the solar PV sector worldwide by 2030.<sup>47</sup> (See Figure 3) A total of 50–53 jobs might be created

per MW of installed capacity, though over time rising labor productivities will reduce these numbers. PV manufacturing is thought to add 10 jobs per MW, installation 33 jobs, wholesaling of systems 3–4 jobs, indirect supply 3–4 jobs, and research: 1–2 jobs.<sup>48</sup> Most jobs will thus be created at the point of installation (installers, retailers and service engineers), giving a boost to local economies.

Even though Europe's share of global production and installations is widely expected to decline, the continent's PV employment will nonetheless continue to grow. Under assumptions summarized in Table 7, jobs may expand to 727,000 in 2020 and 1.4 million in 2030.<sup>49</sup>

Table 7. EU-27 Solar PV Employment Projections, 2007-2030

	2007	2010	2020	2030
<b>Global Solar PV Jobs</b>				
Installations & Wholesale	84,578	238,926	1,750,645	7,850,170
Production, Research, Supply	34,567	94,132	592,263	2,117,295
<b>Total</b>	<b>119,145</b>	<b>333,058</b>	<b>2,342,908</b>	<b>9,967,465</b>

<b>EU-27 Projected Share of World Total</b>				
% of Global Installations	71	52	29	10
% of Global Production	25	25	25	25

<b>EU-27 PV Jobs Calculation</b>				
Installation & Wholesale	71,298	147,500	578,890	880,351
Production/Research/Supply	8,642	23,533	148,066	529,324
<b>Total EU-27 Jobs</b>	<b>79,940</b>	<b>171,033</b>	<b>726,956</b>	<b>1,409,676</b>

Source: Makower, et al., op. cit. note 37, p. 13.

## CONCENTRATING SOLAR POWER AND SOLAR THERMAL ENERGY

Concentrating solar power (CSP) and solar thermal energy (for heating and cooling purposes) are other promising technologies.

A number of CSP plants are under construction or in the planning stage—typically in desert areas or other very hot locations—in Algeria, China, Egypt, Israel, Mexico, Morocco, South Africa, Spain, and the United States. Companies and their suppliers are preparing for a boom in this industry.<sup>50</sup> Greece is completing construction of its first plant in 2009.<sup>51</sup>

Eight of the 13 biggest planned CSP plants will be located in the United States. The construction jobs and employment related to larger plant components (which will likely be sourced in proximity to the plant locations to avoid high transport costs) will be generated in the United States.<sup>52</sup>

But various inputs into the supply chain can generate employment in locations other than where the CSP plants are being built. Among

the European companies that are producing collectors, mirrors/reflectors, and other components for this emerging industry are Abengoa, Acciona Energia, Albiasa, Cristaleria Espanola SA, Samca, Grupo Enhol, and Sener Group (all of Spain); Alanod, Solar Millennium AG, Solar Power Group, Flabeg, Epuron, and Novatec BioSol AG (all of Germany); Glaverbel of Belgium; and Pilkington of the United Kingdom.<sup>53</sup>

In the solar thermal field, China is the undisputed global leader in terms of market size. However, European companies are the technological leaders.<sup>54</sup> The EU market doubled in less than three years. Total solar thermal capacity in operation in the EU and Switzerland reached 15.4 gigawatts-thermal (GW<sub>th</sub>) at the end of 2007.<sup>55</sup> Germany had 35 percent of the European solar thermal market in 2007, followed by Greece, Austria, Spain, France, and Italy with about 10 percent each. Though only holding a 2 percent market share, Poland has a growing domestic industry and is expected to become a more important player.<sup>56</sup>

Germany's solar thermal employment grew from an estimated 12,100 jobs in 2007 to 17,400 in 2008.<sup>57</sup> Spain is in second place in Europe, with currently about 9,000 jobs.<sup>58</sup> In 2006, the Italian solar thermal industry provided almost 2,000 full time (direct and indirect) jobs, and 3,000 jobs were forecast for 2007 (assuming one full-time job per 70 kilowatts-thermal (100 square meters) installed).<sup>59</sup> Using this rough jobs formula, European installations may have provided employment to more than 27,000 people in 2007. Nearly half the industry's employment is generally found in retail, installation, and maintenance.<sup>60</sup>

In 2007, EREC estimated employment in the European solar thermal sector at more than 20,000 full-time jobs. Yet this figure appears highly conservative in light of the above calculation and the combined national estimates for Germany, Spain, and Italy, which alone would indicate employment of about 30,000.<sup>61</sup>

Given the industry's dynamic expansion, in a few decades it may employ **more than half a million** people. Although the manufacturing jobs will be exposed to global competition, retail, installation, and maintenance jobs are local, typically in small and medium sized enterprises.<sup>62</sup>

## BIOENERGY

Biomass can be used for a variety of purposes — biofuels for transport, biogas, and generation of heat and power.

Biofuels projects create employment in the agricultural sector and in processing industries, but also in research, engineering, distribution, and installation. The numbers of existing jobs easily amount to 1 million worldwide (principally in Brazil, and the United States, but also in the EU) and could possibly climb to at least 10 times that much in the future.<sup>63</sup> Various factors such as fluctuating commodity prices, debates about environmental and social benefits versus costs, including conflict with food security, as well as changing policies have somewhat cooled the earlier enthusiasm. It is clear that future growth needs to ensure the sustainability of biofuels projects, with significant GHG emis-

sion reductions and overall positive environmental and social impacts.

Still, global production is continuing to grow. In 2008, bio-ethanol output reached 64 million tons.<sup>64</sup> EU countries account for only about 4 percent of world ethanol output, but feature more prominently in biodiesel. Their production grew from slightly more than 1 million tons in 2002 to 16 million tons in 2008. Germany (33 percent of European output), France (13), Italy (10), and Spain (8) are the largest producers.<sup>65</sup>

Meanwhile, the number of biogas production systems is also growing. According to the European Biomass Industry Association, "in addition to Germany with about 4,000 and Austria with over 300 systems, the boom is also beginning in the East European countries. For example, totally 40 new systems were built in the Czech Republic last year alone. This makes biogas a labor market of the future in which many local and regional jobs will be created."<sup>66</sup>

- **Germany** has an estimated 95,800 direct and indirect jobs in biofuels and other forms of biomass development.<sup>67</sup>
- **Spain** has slightly more than direct 10,000 jobs (4,948 in biomass for heat generation; 2,419 in biofuels; and 2,982 in biogas).<sup>68</sup>
- **France** hopes its proposed biofuel programme may generate 25,000 additional jobs by 2010.<sup>69</sup>

Eastern European countries, with still substantial agriculture sectors, can particularly benefit from biofuels and biomass development because it contributes to rural income generation.

Some studies have attempted to come up with a formula of jobs created per unit of output. One report claims that 4,900 jobs are created for each GW of biomass power. Another study says that 4,500 jobs could be created per 1 million liters of ethanol produced.<sup>70</sup> A 2007 study by GHK, Institute for European Environmental Policy (IEEP), and Cambridge Econometrics projected that replacing 10 percent share of

fuel consumption with biofuels could yield a net gain of 108,100 direct jobs and 31,400 indirect jobs in the agriculture sector.<sup>71</sup>

Other studies predict higher job gains. A 2006 study posited that some 580,000 jobs could be generated over the next decade in installing and operating biomass heating systems, including production, processing, and distribution of the raw material. A report by EREC estimated that meeting the EU 2010 renewables target will result in a net gain of 424,000 jobs in the biofuels sector.<sup>72</sup> Finally, a 2007 report by the Öko-Institut and the Institut für Energetik in Germany indicates that the European sustainable production for biomethane may be

500 billion cubic meters per year. This could generate 2.7 million new jobs in the EU, mainly in agriculture and manufacturing, construction and management of biogas plants and biogas purification plants.<sup>73</sup>

The studies and estimates surveyed above suggest that a sizable renewable energy industry has emerged in Europe. Employment in this sector is still concentrated in a fairly small number of countries—Germany and Spain in particular. But it is also become clear that others are increasingly following in the footsteps of the pioneering countries, and it is thus very likely that they will see growing numbers of jobs in wind, solar, and bioenergy industries.

**Table 8. European Employment in the Renewable Energy Sector, 2007/2008**

Renewable Energy Source	Selected Countries	
Wind Power Europe: 160,000	Germany Spain Denmark* France* United Kingdom	85,100 40,000 23,500 7,000 4,000
Solar PV Europe: 80,000	Germany Spain France Italy	42,000 26,800 3,500 1,700
Solar Thermal Energy Europe: 30,000	Germany Spain* Italy	17,400 9,142 3,000
Bioenergy Europe: > 106,000	Germany Spain*	95,800 10,349

\* Direct jobs only.

Table 8 summarizes jobs estimates in the renewable energy industry in Europe. They suggest that, at a minimum, Europe has some 376,000 jobs in this sector. This is a conservative estimate because it does not fully

capture employment in the supply chain. There are also a number of additional jobs in the small hydropower and geothermal industries. Adding these would likely bring the total employment figure to well over 400,000.

# TRANSPORT

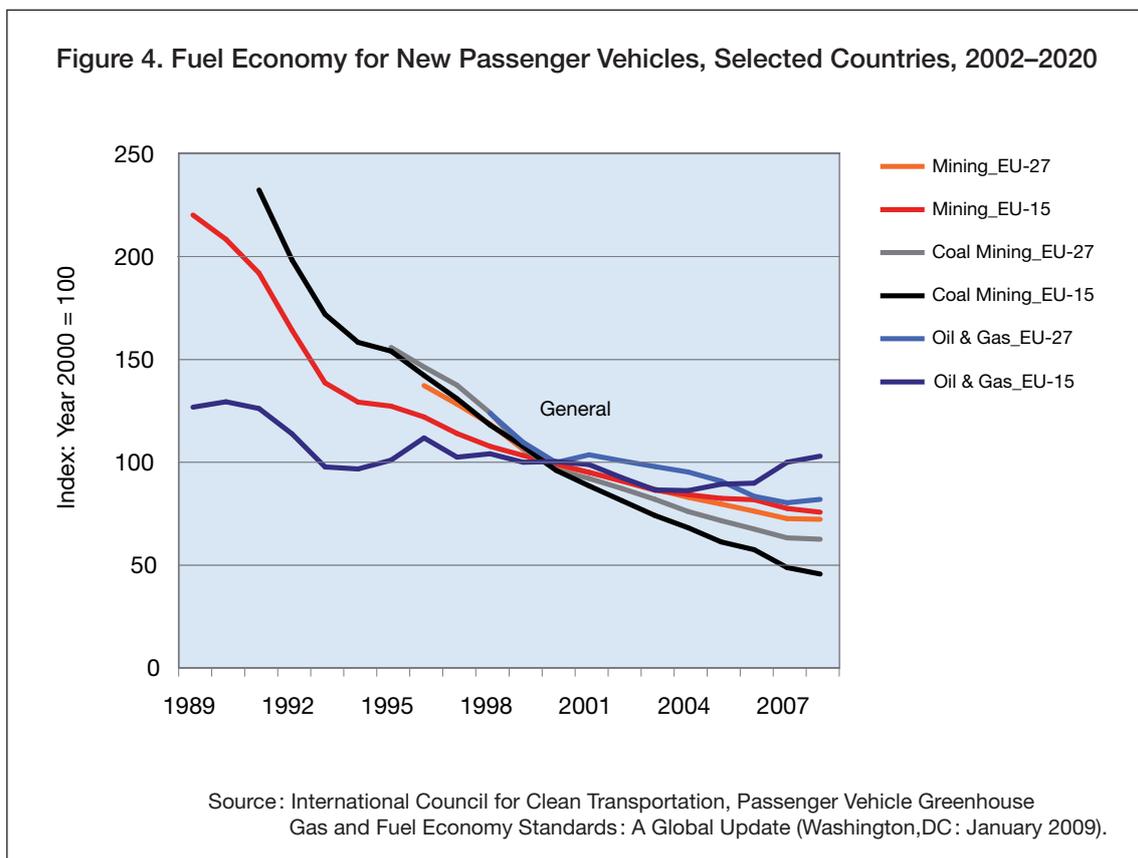
Road transport accounts for 74 percent of overall transport CO<sub>2</sub> emissions and for the majority of jobs in the sector.<sup>74</sup> An array of measures can help to reduce the carbon footprint of motor vehicles, ranging from fuel-efficiency technologies to hybrid vehicles, and plug-in electric vehicles. Such technological developments could portend many job opportunities in the future.

Beset first by rollercoaster oil prices and the global financial crisis, the world's automobile industry is now in deep crisis. Global production of passenger cars and light trucks is forecast to decline from about 71 million units in 2007 to less than 60 million in 2009.<sup>75</sup> In Europe, new passenger car registrations fell by 7.8 percent in 2008.<sup>76</sup> Automakers are closing plants, shedding jobs, and reducing working hours for their employees. At the same time, there is growing pressure on the industry to produce more efficient and less polluting cars in the face of the gathering climate crisis. The

auto industry plays a critical role in the economies of several European countries such as Germany, France, and Spain, but also in the United Kingdom, Italy, Poland, and the Czech Republic.<sup>77</sup> Many hundreds of thousands of jobs—and more at supplier companies and other firms—are at stake.

## AUTOMOBILE FUEL EFFICIENCY

How many of Europe's auto-manufacturing jobs can be considered a shade of green by virtue of high fuel-efficiency? Efficiency is a relative concept, with inherent difficulties in setting an unambiguous threshold that separates gas sippers from gas guzzlers. The International Council on Clean Transportation (ICCT) concludes that worldwide, Japanese and European car factories produce the most efficient vehicles available today—a lead that looks like it will be extended in coming years.<sup>78</sup> (See Figure 4)



Because carbon emission limits imply higher fuel efficiency, the European Commission's December 2007 proposal on Regulation to Reduce the CO<sub>2</sub> Emissions from Passenger Cars can serve as a benchmark for determining what share of the auto industry's workforce is involved in producing more fuel-efficient vehicles that emit less carbon.<sup>79</sup> Data from Commission monitoring reports are being

used here to construct a rough, back-of-the-envelope estimate.<sup>80</sup> Among members of the European Automobile Manufacturers Association (ACEA), about 26 percent of passenger vehicles sold in 2004 satisfied a limit of 140 grams per kilometer of driving. But only 7.5 percent of vehicles sold met a stricter standard of 120 g CO<sub>2</sub>/km.<sup>81</sup> (See Table 9)

Table 9. Estimated Jobs Producing Fuel-Efficient Vehicles, European Manufacturers, 2004

	Vehicle Production / Employment	
	Number of vehicles	
Vehicles sold in Europe by ACEA members	11,484,785	
Of which vehicles emitting less than :	120 g CO <sub>2</sub> /km: 879,401	140 g CO <sub>2</sub> /km: 3,085,165
Share of total sales	7.5 percent	26.3 percent
	Number of Employees	
Passenger car manufacturing workforce	2,000,000	
Percentage share of "clean" vehicles, pro-rated vis-à-vis workforce total	150,000	526,000

Source: European Federation for Transport and Environment (T&E), Reducing CO<sub>2</sub> Emissions from New Cars: A Study of Major Car Manufacturers' Progress in 2007 (Brussels, August 2008).

Assuming that the portion of sales that is represented by efficient cars can be applied to the industry's workforce, some **150,000** auto industry jobs could be considered a shade of green under the stricter standard and **526,000** jobs under the more lenient one.<sup>82</sup> Given the urgent need to rein in vehicular carbon emissions, the lower limit would appear to be a more meaningful gauge of what may be considered sufficiently efficient vehicles.

But there are great variations among European countries and companies. According to the European Federation for Transport and Environment (T&E), French and Italian firms fared best in terms of offering vehicles with low carbon emissions, whereas German-produced vehicles have relatively high emissions values.<sup>83</sup> This means, in rough terms, that a larger share of the 500,000 jobs in the French and Italian auto industry can be considered somewhat green, and a smaller share of the 733,000 German jobs.<sup>84</sup> Of course, given the fact that car manufacturers source materials and inputs from an array of locations, a far more fine-grained analysis of factories would be needed.

The EC is aiming for carbon emission limits for new passenger cars of 130 grams of CO<sub>2</sub> per kilometer. Automakers will be expected to have 65 percent of their fleets in compliance by January 2012, rising to 100 percent by 2015.<sup>85</sup> However, first proposed in 1995, these standards have been pushed back from an original target of 2005 and were watered down in December 2007, due to industry pressure.<sup>86</sup> Thus, even though European car manufacturers fare well in international comparison, their carbon footprint is still high relative to what a cutting-edge, climate-responsible strategy would suggest.

Because the climate crisis demands that vehicles emit less and less carbon, the benchmark for what constitutes a sufficiently efficient vehicle (and what represents a "green" auto industry job) will need to become more and more strict. T&E advocates for a limit of 80 g/km by 2020 and 60 g/km by 2025.<sup>87</sup> (The EC envisions a 2020 target of 95 g/km, but has not adopted this as a firm goal.<sup>88</sup>) The climate impact of the European car industry can be reduced, and jobs can be made greener, by continued action on carbon emissions standards and related policies to assist the industry in the transition.

## HYBRID VEHICLES

Besides technologies that improve the fuel efficiency of conventional combustion engines, hybrid-electric vehicles (HEVs) and plug-in electric vehicles (PHEVs) are generally seen as a key means to achieve higher fuel efficiency.

Because hybrids encompass an electric engine in addition to a conventional gasoline motor (plus a battery to power the extra motor), these cars require additional inputs and thus their production may be assumed to entail more employment than a regular car. For plug-ins there is also a need for an accompanying infrastructure<sup>89</sup> (charging stations, electrical grid expansion/improvements); this also implies growing employment opportunities at pioneering companies like California-based Better Place.

The development of hybrids and plug-in electric cars will likely be a boon for manufacturers of batteries (such as nickel metal hydride and lithium ion). If batteries can be made sufficiently cheap, reliable, safe, and recyclable, this may lead to the creation of a substantial number of jobs. Companies in this emerging field include Ener1, A123 Systems, and Johnson Controls (in the United States), Panasonic, NEC, Sanyo, Matsushita Electric, and Toshiba, (Japan), LG Chem, Samsung, and Enertech (South Korea), Varta, Bosch, Continental, and Evonik Industries (Germany), and Saft (France). But most batteries used for hybrids are currently built in China, Japan and other Asian countries.<sup>90</sup>

In 2008, slightly more than half a million gasoline-electric hybrids were produced worldwide, most of them by Toyota.<sup>91</sup> PricewaterhouseCoopers projects that by 2015 some 2.7 million gasoline hybrids might be produced, along with 250,000 diesel hybrids and 145,000 electric vehicles. Their share of total car production might thus grow from 0.7 percent today to 3.7 percent.<sup>92</sup> European car manufacturers largely missed the opportunity to be pioneers, and are now trying to catch up with Japanese firms.<sup>93</sup>

There are calls in all industrialized countries for moving toward PHEVs. The EU, for instance, has called for 1 million such vehicles by 2020.<sup>94</sup>

In Germany, the government is aiming to put 1 million electric and plug-in hybrid electric vehicles on Germany's roads by 2020, and at least 5 million by 2030.<sup>95</sup>

Meanwhile, a number of automakers have announced plans to offer such vehicles. Making its debut in December 2008 in China, BYD Auto's F3DM is the first mass-produced plug-in hybrid. It is also to be introduced in Europe in 2010 and in the United States in 2011.<sup>96</sup> China's Chery will also offer a model by 2010.<sup>97</sup> India's Tata similarly is promising an electric vehicle to be sold in Europe during 2009.<sup>98</sup> Toyota will introduce a plug-in hybrid in late 2009, followed by VW and GM in 2010.<sup>99</sup> It is too early to project the employment that will arise in this new branch of the auto industry and what share of it may be garnered by Europe.

The current auto industry crisis presents a unique opportunity to "green" this sector—if governments can be convinced that the challenge is not simply to subsidize carmakers or revive car sales, but to put in motion a fundamental transformation of this industry. The European Commission, for instance, has proposed a €5 billion "green cars initiative" to be funded by the Commission, member states, the European Investment Bank (EIB), and private industry.<sup>100</sup>

## URBAN TRANSPORT, CAR-SHARING AND BICYCLES

A climate-sensitive transport policy needs to go beyond more efficient automobiles and address the severe imbalance among different modes. This means promoting and reinvigorating urban public transport, along with bicycling and walking, as well as inter-city rail. Though not without its share of environmental issues, urban transport is more climate-friendly than the automobile system. A shift would help meet climate goals and create net employment gains.

According to the International Association of Public Transport (UITP), an estimated 900,000 people are employed in urban public transport in the 25 member states of the European Union. UITP has 2,900 members from 90 countries, and national statistics from these countries suggest that the number of direct jobs in public transport amounts to about 1–2 percent of total employment.<sup>101</sup> Urban transport agencies are major employers. In Paris, RATP (Régie Autonome des Transports Parisiens de France) employs 43,600 people. STIB (Société Transport Intercommunaux de Bruxelles) in Brussels has more than 6,000 employees.<sup>102</sup>

Public transport investments in Europe have an average job multiplier effect of 2 to 2.5 (but reaching as high as 4.1 in some cases). Studies in Europe and the United States show that about 30 jobs are created for each €1 million invested in public transport infrastructure, and 57 jobs for the same level of investment on the transport operations side.<sup>103</sup> An Öko-Institut study estimated in 2003 that even in the short-run, an expansion of local public transport could yield a net gain of **200,000** jobs by 2010 in Germany.<sup>104</sup> Denmark will likely see an expansion of transport jobs, since its parliament decided to focus the country's economic stimulus package on transport, and especially on public modes.<sup>105</sup>

A 2005 survey of about 170 cities by UITP found that inefficient and polluting diesel buses account for about 90 percent of all urban buses in EU countries. Less-polluting alternatives are particularly prevalent in Helsinki and Athens (CNG), Vienna (LPG), and Luxembourg (biodiesel, hybrids).<sup>106</sup> In addition to job gains

from replacing old, polluting buses, there are also employment opportunities in retrofitting buses to reduce air pollution.

Though still limited to date, car-sharing programmes offer individual mobility while reducing the number of vehicles in circulation. In 2003, the Öko-Institut estimated the German employment potential in a systematic expansion of car-sharing at 14,000 by 2010 (a net gain of 8,000 after job losses in road vehicle manufacturing, retail trade, and insurance and oil industries are taken into account).<sup>107</sup> A simple extrapolation based on population size suggests that Europe-wide close to 50,000 jobs could be created within a relatively short time frame, given supportive policies.

Urban policies that promote bicycle use in place of short-distance car trips help reduce carbon emissions and can create extra jobs. Worldwide, more than 100 million bicycles are produced annually (though output has fluctuated considerably). The bicycle industry offers employment in dozens of countries, but just five producers—China, India, the European Union, Taiwan, and Japan—account for 87 percent of global production. China alone produces more than half the world's bicycles. Production of electric bicycles—with a small electric motor that assists pedaling uphill or allows riders to cover longer distances more easily—is booming, reaching about 12 million units in 2005. Almost all of them were manufactured in China.<sup>108</sup>

No reliable global employment statistics appear to exist for this industry, or for associated businesses such as rental services.<sup>109</sup> It is clear, however, that most jobs in manufacturing bicycles are in Asia, whereas sales and rental jobs, and those associated with building bike paths and other infrastructure, are out of necessity much more local in nature. There are enormous differences among European cities, with places like Amsterdam or Copenhagen being far more bicycle-friendly than others, and this suggests that associated local employment varies tremendously.

## RAIL

Rail transport is more fuel-efficient and more labor-intensive than road transport.<sup>110</sup> German studies suggest this is true for track construction relative to road construction as well. Indeed, highway construction generates the fewest jobs of any public infrastructure investment.<sup>111</sup>

Yet, in many countries, trends in inter-urban transport have been strongly in favor of road vehicles, moving away from rail transport for both passengers and freight. Although the quantity of passenger-kilometers and ton-kilometers in Europe increased in absolute terms, in 2005, rail transport's share of passenger and freight traffic decreased, and stood at 5.8 percent and 10 percent, respectively.<sup>112</sup> In the EU-25, the road and motorway network accounts for 95 percent of the length of all transport routes. Road length grew by 22 percent between 1990 and 2003, whereas the railway network shrunk by 8 percent to under 200,000 kilometers.<sup>113</sup>

In the EU-25, a total of 8.2 million people were employed in all transport services combined in 2004. Railway transport—far less fuel-intensive and polluting than trucking and other road transport—accounted for just 11 percent, or 900,000 jobs. Rail employment has fallen in the last few decades; in just the short span of time between 2000 and 2004, the number of jobs was cut by 14 percent even as value-added grew 3 percent. Road passenger and freight transport jobs, by contrast, number some 4.3 million, and air transport jobs number 400,000.<sup>114</sup>

In 2004, transport equipment manufacturing employed about 3 million persons in the EU-25, accounting for 9 percent of the EU-25's manufacturing workforce. The manufacture of motor vehicles, trailers, and semi-trailers represented more than two-thirds of these jobs.<sup>115</sup> The manufacture of railway and tramway locomotives and rolling stock in the EU-25 employed just 140,000 people in 2003, or half a percent of all industrial employment.<sup>116</sup>

Even though a sustainable transport policy may ultimately lead to fewer jobs in car manufacturing and related fields such as vehicle retailing and repair services, it offers more jobs in manufacturing of buses, light rail, subways, and railways; in the provision of the required infrastructure for these modes of transport (including tracks, signals, stations, etc.); and in planning, running, and maintaining transport systems (bus drivers, conductors, and other operators; route planners, maintenance staff, etc.).

What would happen if a substantial modal shift occurred away from heavy reliance on cars? Would it lead to a net gain or net loss of jobs? Assessments of alternative passenger transport policies conducted in Germany and Britain, though dated now, offer useful insights. A 1998 study by the Öko-Institut in Germany suggests that **job gains would clearly outweigh losses.**<sup>117</sup> A study conducted by ECO-TEC for Friends of the Earth Great Britain in 1997 offered similar optimistic conclusions.<sup>118</sup> Among English-language studies, the ECO-TEC study remains “the most complete in measuring the employment effects linked to the implementation of sustainable-development transport policies.”<sup>119</sup>

# ENERGY EFFICIENCY

Beyond the transport sector, energy efficiency is critical in other parts of the economy as well.

A 2005 European Commission study, *Doing More with Less*, surveyed available studies of the job creation potential and offered the following findings:

- As a rough rule of thumb, it seems reasonable to assume that efficiency gains of 1 percent per year for a 10-year period could lead to over 2 million person-years of employment.<sup>120</sup>
- Energy efficiency investments to save 20 percent of EU energy consumption can create up to 1 million direct and indirect jobs in Europe.<sup>121</sup>

Similarly, a study for the European Foundation for the Improvement of Living and Working Conditions found that the adoption of energy conservation best available technologies could create 500,000 extra jobs in the EU.<sup>122</sup> A comprehensive study by the Association for the Conservation of Energy in the UK found that per €1 million of total expenditure (both government and private), energy efficiency programmes typically resulted in 8 to 14 additional person-years of employment.<sup>123</sup>

Compared with the jobs created by extraction, transformation and distribution of energy, cost-effective energy-efficiency investments offer more employment—in part because money saved from reduced energy use can be spent in other sectors of the economy that are more labor-intensive than the energy industry.

Table 10. European Industry Associations Providing Goods and Services for Energy Efficiency

Industry Association	Description	Workforce
EuroAce	European Alliance of Companies for Energy Efficiency in Buildings. Twenty leading companies in manufacture, distribution and installation of various energy-saving goods and services.	328,000
Eurima	European Insulation Manufacturers Association (representing major mineral wool insulation producers)	>20,000 (+ installation of insulation products: 300,000)
BING	Representing the rigid polyurethane insulation industry.	18,000
CECED	Household appliance manufacturing industry.	>200,000 direct (>500,000 incl. up-/downstream)
ELC Federation	European Lamp Companies Federation (95 percent of European lamp production).	50,000
Glass for Europe	Manufacturers of building, automotive, and transport glass; currently 3 member companies (AGC, Pilkington, Saint-Gobain Glass)	>16,000
COGEN Europe	Umbrella group representing Europe's cogeneration (CHP) industry and key users (incl. gas and electricity firms, ESCOs, equipment suppliers, consultancies, etc.)	n.a.

Source: European Commission "Doing More with Less".

Efficient industrial processes and boilers, or improved building maintenance, will generate as much or more employment per Euro invested than spending on roads, bridges, and energy transmission networks. The 2005 EC study refers to findings of an estimated 12–16 job-years of direct employment created for every \$1 million invested in energy efficiency, compared with just 4.1 job-years for investing in coal-fired power plants or 4.5 job-years in nuclear power plants. Energy end-use efficiency investments create three to four times the number of jobs created by comparable energy supply investments, i.e., coal-fired and nuclear power plants.<sup>124</sup>

A number of industries provide various inputs—goods and services—relevant to energy efficiency of buildings, heating and cooling, appliances, and lighting. Table 10 offers an overview.<sup>125</sup> The workforce figures indicate the scale of possible efficiency-related jobs at present, but are not all necessarily equivalent to green jobs. For example, the household appliance industry manufactures products of various degrees of efficiency, and only the top runners ought to be considered green.

## BUILDINGS

The building sector is responsible for 40 percent of EU final energy consumption.<sup>126</sup> If Swedish standards were applied across Europe—the country has the best-insulated buildings on the Continent—energy savings of more than 50 percent could be achieved. The greatest energy savings potential—and thus job creation—is found in central and southern Europe. Italy alone represents 17.5 per cent of the annual energy loss from European dwellings, equivalent to 86,000 million tons of CO<sub>2</sub> emissions per year.<sup>127</sup>

In Germany, says a 2003 study by the Öko-Institut, retrofitting buildings could yield a net gain of 110,000 jobs by 2010. Building energy audits also promise employment. By 2003, only 7 percent of 1.3 million public buildings in Germany had been analyzed for energy savings. Increasing that portion to one-third could generate some 30,000 jobs. Even after job losses are factored in (in the energy supply sector, for instance), a net job gain of 10,000 would result.<sup>128</sup>

The EU is considering making its existing Energy Performance of Buildings Directive (EPBD) more stringent. Commission staff has examined a range of proposals and options and assessed the likely job implications. Between 280,000 and 450,000 new jobs might be created by 2020, chiefly among energy auditors and certifiers, inspectors of heating and air-conditioning systems, in the construction sector, and in industries that produce materials components and products needed to improve the performance of buildings.<sup>129</sup> Eurima, the insulation industry umbrella group, provides more optimistic projections, projecting additional employment figures ranging from 274,000 to 856,000 jobs.<sup>130</sup> And a study by the European Trade Union Congress and others estimated that up to **2.59 million jobs** could be created by 2030.<sup>131</sup>

A worldwide transition to energy-efficient buildings would create millions of jobs, as well as greening existing employment for many of the estimated 111 million people already working in the construction sector. Investments in improved energy efficiency in buildings could generate an additional 2–3.5 million green jobs in Europe and the United States alone, with the potential much higher in developing countries.<sup>132</sup>

## HOUSEHOLD APPLIANCES

Household energy needs account for 25 percent of the total energy demand in the EU. Because of the introduction of a range of new products in recent years, energy consumption has sharply increased.<sup>133</sup> Also, there are still about 188 million refrigerators and freezers 10 years or older in European households. Whereas appliances of 1990 vintage typically consume about 600 kWh per year, those that meet the criteria for energy efficiency Label A+ use approximately 255 kWh; top-of-the-line A++ appliances consume about 182 kWh.<sup>134</sup>

The use of eco labels has helped increase the sales share of efficient refrigerators in the EU. Label A units altogether increased their market share from about 2 percent in 1992 to almost 45 percent in 2003 and about 60 percent in 2005.<sup>135</sup> While the share of less efficient labels has thus fallen strongly, the highest efficiency class of A++ is attained by only about 4 percent

of appliances.<sup>136</sup> Using the A++ label as the benchmark for measuring green jobs in this sector would thus yield a far smaller figure than the A label.

The European household appliances industry employs around 200,000 workers, with about 23,000 people working in factories producing refrigerators and freezers. However, some 57,000 jobs have been lost in Western Europe over the past two decades. In Eastern Europe, the industry collapsed after the fall of Communism; only about **20,000** new jobs have been created since then. Western Europe's appliance manufacturing has moved to some extent toward Eastern Europe, but also to Russia and Turkey, and generally from Europe to China.<sup>137</sup>

A report by the European Economic and Social Committee (EESC) argues that Europe's household appliances industry needs to compete on quality (including environmental aspects), not price, implying a continuous need for technology innovation and employee skills training.

*“Such policy should foster the development of energy-efficient household appliances, with enhanced recycling capacity. The overall environmental impact, based on lifecycle analysis, should be minimised. The EESC firmly believes that the European Union legislation could have a direct influence on the competitiveness of the sector, mainly through the proposal for the extension of the Ecodesign Directive and the proposal for the revision of the Ecolabel Regulation, resulting in increased energy efficiency and reduced CO<sub>2</sub> emissions. So as to reduce the threat and trend of relocation of industry outside Europe, the loss of jobs and the risk of curbing consumers' interest.”<sup>138</sup>*

## LIGHTING

Lighting is an important component of energy consumption in buildings. Inefficient incandescent lamps are to be phased out from the EU market between 2009 and 2012.

A December 2008 EU briefing document concludes:

*“Most incandescent lamps sold today in the EU are produced in the EU, whilst most lamps with integrated electronics (such as compact fluorescent lamps) are produced in third countries. Halogens are produced locally and imported in more or less equal proportions. Therefore, a shift towards lamps with integrated electronics is likely to cause a shift of production away from the EU. The total number of workforce assigned to incandescent lamp production for European sales is in the order of 8,000 people in total out of the 50,000 people producing lamps in the EU. However, the shift in production has already taken place to a large extent. [...] Overall, at most 2,000 to 3,000 jobs are estimated to become redundant after the incandescent lamp phase-out.”<sup>139</sup>*

These would mainly be in Eastern Europe, where Hungary and Poland have big incandescent factories.<sup>140</sup>

It is China that is producing the bulk of efficient compact fluorescent light (CFL) bulbs. According to recent figures, the country accounts for 80 percent of CFL production worldwide, some 3 billion units in 2007.<sup>141</sup>

It is possible that Europe will have a larger role in producing light-emitting diodes (LEDs) in coming years. LEDs are still a very small, but fast-growing (40-60 percent per year), segment of the lighting market. In 2007, the global LED market was \$4.6 billion, and just 7 percent of these sales were for lighting purposes. The total lighting market worldwide, by contrast, runs to anywhere from \$40 billion to \$100 billion. They tend to last longer and are even more efficient than CFLs.<sup>142</sup>

The three largest lighting companies in the world—Philips of the Netherlands, Osram of Germany, and General Electric of the United

States—have staked out strong positions in the emerging LED market. More broadly, a range of European and North American companies are involved in LED product design, marketing and selling, but they mostly outsource the manufacturing to Asian firms. Philips and Osram are involved in manufacturing LED chips and other components, though part of this takes place in facilities in California.<sup>143</sup> It remains to be seen to what extent the LED market translates into jobs in Europe.

## COMBINED HEAT AND POWER

Combined heat and power (CHP, also referred to as cogeneration) captures waste heat in electricity production or industrial processes and recycles it into useful electricity and thermal power. CHP systems utilize 75–90 percent of fuel input, far more than a typical coal-fired power plant (33 percent) or natural gas-fired plants (60–64 percent). About 80 percent of CHP systems worldwide are used in energy-intensive sectors like paper and printing, chemicals, metal and oil refining, and food processing.<sup>144</sup> They help increase industrial energy efficiency and thus reduce carbon emissions.

A number of European countries are already using CHP fairly extensively. Compared with an average global share of 8 percent of electricity needs being met with the help of CHP facilities, Denmark derives 52 percent of its power needs in this manner. In Finland, CHP accounts for 39 percent, in Russia for 32 percent, in the Netherlands 29 percent, and in Poland and Romania 26 percent each.<sup>145</sup>

Table 11. CHP Installed Capacity, World and Selected Countries, recent years

Country	Installed CHP capacity (MW)
United States	84,707
Russia	65,100
China	28,153
Germany	20,840
Poland	8,310
Netherlands	7,160
France	6,600
Spain	6,045
Italy	5,890
Finland	5,830
Denmark	5,690
United Kingdom	5,440
Slovakia	5,410
Romania	5,250
Czech Republic	5,200
Sweden	3,490
World	329,168

Source: Dick Munson “Recycled Energy”.

Worldwide, CHP systems have a combined generating capacity of 329 GW. The United States has the largest capacity (85 GW), followed by Russia, China, and Germany. Poland leads a number of European countries whose capacity, in absolute terms, is smaller, but quite significant relative to the size of their energy sectors. Boosting efficiency through CHP is especially significant for countries like Poland and other Eastern European countries which still rely heavily on coal.<sup>146</sup> (See Table 11)

In the United States, a rough estimate suggests that about 25 workers are required for operating and maintaining 10 MW of existing CHP capacity.<sup>147</sup> European countries have a CHP capacity of 104 GW—32 percent of the global total. Applying the U.S. job per MW estimate to the European context yields the following calculation:  $25 \times (104,000/10) = \mathbf{260,000 \text{ jobs}}$ . Of course, this figure needs to be seen with some caution. Not only is the U.S. formula no more than a rough estimate, but it is unclear whether it is typical of European conditions.

Applied to Germany, the formula suggests roughly 52,000 CHP jobs in Germany. The Öko-Institut concluded in 2003 that some 15,000 CHP jobs (gross) could be created in Germany over a 7-year period (by 2010).<sup>148</sup> Since this refers to job gain rather than total CHP jobs, this estimate may well be consistent with the above calculation.

Beyond the direct employment are jobs at supplier companies, site developers, firms involved in designing, constructing, and installing CHP facilities and related equipment, as well as those in energy efficiency consulting. All in all, the pursuit of CHP promises more employment than can be generated by conventional power plants.

Some of the European companies service not just their domestic or EU market, but also export markets, and this implies additional employment, although it seems difficult to quantify this. The United Kingdom is the leading exporter of CHP facilities, with a share of more than 20 percent of global exports. UK companies also control about 13 percent of global trade in efficient power plant technologies; German firms have a 12 percent share.<sup>149</sup>

CHP is likely to play a growing role in years to come, perhaps more than doubling in Europe by 2025 to reach a share of 17 percent of power generation.<sup>150</sup> A 2004 European Union directive asked member states to undertake comprehensive national studies and remove barriers to wider CHP use.<sup>151</sup> The share of CHP-generated electricity is supposed to double in Germany by 2020 to about 25 percent, and the German government thinks that the share of power from CHP systems could grow from 13 percent in 2005 to 57 percent eventually, implying possibly a 4-fold expansion.<sup>152</sup> This promises a substantial number of additional jobs.

# CONCLUSIONS

Europe's leadership in climate policy, especially with regard to promoting renewable sources of energy, has yielded a growing number of green jobs. Yet, this is only a beginning. A much greater transition still lies ahead, and it promises millions of additional green jobs. But the current juncture of climate crisis and economic crisis is critical. The stimulus packages announced so far in Europe are green only to a limited degree—a mild boost instead of a turbo-charge.

It is crucial that the EU and its Member States sincerely commit to substantively strengthening the December 2008 climate and energy package towards at least a 30 percent domestic GHG reduction target by 2020. Doing so would allow them to harvest green job creation opportunities more fully. EU policy will influence, and be influenced by, the road to Copenhagen—the process to forge a new global agreement at the UNFCCC COP15 to amend the Kyoto Protocol. Success is vital for accelerating green job growth.

Europe now has close to 400,000 jobs in the renewable energy sector, with good prospects that the numbers will mushroom to a few million in the next decade or so. The numbers projected vary from one study to the next, but collectively, existing assessments leave little doubt of the great potential ahead.

The transport sector is likely to experience considerable tumult, as the one-sided, car-centred policies of the past now look like a dead-end strategy. For economic and environmental reasons, a new orientation is needed—both with regard to vehicles with a far smaller carbon footprint (i.e., pursuing greater fuel efficiency and new propulsion systems including electrification of transport as a key policy) and a better-balanced mix of modes that re-prioritizes rail and public transport. This may require an almost unprecedented conversion of auto industry capacities and job skills, and a strategic commitment to a smart grid and other forms of public infrastructure.

Currently, an estimated 150,000 people are directly involved in producing efficient automobiles. Close to 2 million people are working in urban transport, railway operations, and manufacturing of locomotives and rolling stock. Including indirect jobs would at least double these numbers.

Energy efficiency generally holds enormous promise to cut carbon emissions and to create jobs. In most areas—buildings and lighting, appliances and office equipment, industrial processes, etc.—we have only seen modest beginnings. An earnest effort to pursue efficiency opportunities can generate large numbers of jobs. In light of global competition, a high-efficiency, low-carbon strategy may be the only realistic option for keeping certain industries and jobs in Europe that otherwise may soon be outsourced.

It is difficult to come up with a comprehensive figure for employment in energy efficiency. However, available figures for the number of people working in insulation materials and installations, building energy efficiency goods and services, and combined heat and power in Europe add up to more than 900,000 jobs.

**Some 400,000 renewables jobs (direct and indirect), some 2.1 million in efficient transport, and more than 900,000 in energy efficiency goods and services add up to some 3.4 million green jobs in Europe already today. Indirect jobs not included above are likely to add another 5 million to the employment figure.**

Still, these are conservative figures, since they do not include additional green jobs in such areas as manufacturing efficient appliances, lighting, and other equipment and industrial machinery. Also these figures do not include the potential for job gains by already saved fuel and energy bills. Compared to the United States, for instance, a much lower per capita electricity and fuel consumption is likely to

generate additional employment in the service sectors as purchasing power of citizens is higher in Europe. Those new jobs in the tertiary and service sectors are likely to grow substantively with a much tougher resources economy.

Where once it was just a handful of pioneers, now a growing number of European governments are putting in place policies to support the development of renewable energy and energy efficiency— from feed-in and net metering laws to solar roof programmes to efficiency standards and eco-labels. Although Eastern European countries—concerned with the impacts on their coal-dependent economies—have been more reluctant in this regard, this has begun to change, and it would be a mistake to regard climate policies as an East-West divide. EU directives and regulations can drive forward this process, along with a greater use of Cohesion funds for green purposes.

An ambitious EU climate policy must be embedded in a broad social consensus. And in order to design better policies, a more detailed sectoral and regional analysis is required to identify the type and scale of jobs that are at risk as well as the opportunities that may arise, while defining the accompanying measures for a transition to a sustainable European economy. Putting in place fair transition measures to assist communities and regions that will face an adjustment challenge can go a long way to addressing concerns about job loss and the associated social impacts.

It is also important that EU-wide education and skill-building programmes be put in place. This is important not only for those who may need retraining for new jobs and new careers. It is equally important for ensuring that the renewables and efficiency revolution does not run out of steam for lack of adequately-skilled workers.

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- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption

**WWF European Policy Office**

168 avenue de Tervurenlaan Box 20  
B-1150 Brussels

Tel: +32 2 743 88 00

Fax: +32 2 743 88 19

E-mail: [wwf-epo@wwfepo.org](mailto:wwf-epo@wwfepo.org)

[www.panda.org/eu](http://www.panda.org/eu)



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