Joint Implementation in the Context of European Union Accession

The Case of the Czech Republic

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Abbreviations and Acronyms

AIJ	Activities implemented jointly
BAT	Best available techniques
BAU	Business as usual
BREF	BAT reference document
CDM	Clean development mechanism
CEA	Czech Environmental Agency
CEECs	Central and Eastern European Countries
CER	Certified emission reduction
CHP	Combined heat and power
COP	Conference of Parties (U.N. Framework Convention on Climate Change)
CZK	Czech crown (local currency unit)
DH	District heat
EC	European Commission
ECCP	European Climate Change Program
EIA	Environment impact assessment
ELV	Emission limit value
ER	Emission reduction
ERU	Emission reduction unit
ET	Emission trading
EU	European Union
GBRs	General binding rules
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
HGS	High growth scenario
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated prevention and pollution control
JI	Joint implementation
KP	Kyoto Protocol
LCP	Large combustion plants
Mt	Million tonnes
NIS	New independent states
NOx	Nitrogen oxides
NPP	Nuclear power plant
NPV	Net present value
NSS JI	National strategic study on JI
PCF	Prototype Carbon Fund
PEFC	Pan-European forest certification scheme
RS	Reference scenario
SFZP CR	State Environmental Fund of Czech republic (Statni fond zivotniho prostredi)
SMW	Solid municipal waste
UNFCCC	U.N. Framework Convention on Climate Change
VOC	Volatile organic compound

Executive Summary

The purpose of this study is to examine how the Czech Republic's impending membership in the European Union will impact on the potential supply of joint implementations (JI) projects. The Czech Republic was the first country to host AIJ (activities implemented jointly) projects in the first half of the 1990s. Since then expectations about project-based emission reduction mechanisms have been tempered by both the flexibility mechanisms introduced by the Kyoto Protocol and the increasing complexity of the rules governing joint implementation (JI). It has also been tempered by the economic and environmental situation of the country, which has substantially improved over the past decade.

The Czech Republic is a candidate for membership in the European Union (EU) and the accession process is thus an integral part of the "business as usual" scenario. This process and eventual EU membership has important impacts on the potential supply of JI opportunities. Indeed, new permitting and planning procedures, stricter emission limit values or requirements for use of "best available techniques" among others, are likely to create tighter environmental requirements and thus additional project compliance requirements. This in turn may raise abatement costs per emission reduction unit (ERU).

EU directives that will affect baselines for JI projects in the Czech Republic are (1) the Integrated Prevention and Pollution Control Directive, which concerns all major industrial installations, as well as large combustion plants, (2) the SAVE Directive on energy conservation, (3) the Landfill Directive on waste management, and (4) the Electricity and Gas Directives on energy markets. Each of these directives is analyzed in detail in terms of its potential impact on joint implementation projects.

Using the MARKAL model for energy production and energy use, the authors estimate that EU membership reduces the potential for JI projects by 29 percent to about 13 $MtCO_{2eq}$ per year. Of these projects, only 18 percent (2.4 $MtCO_{2eq}$ per year) consist of "tradable" measures, that is, measures with annual emission reduction potential of 1,000 or more tonnes of CO_{2eq}. The rest are very small projects requiring special bundling procedures to reduce transaction costs.

This "tradable" block of projects encompasses 345 items in the catalogue of emission reduction projects, which is part of the MARKAL model for the Czech Republic. They are mostly renewable energy projects in the industry and municipal heating sectors. Assuming a price of carbon of 5 USD per tonne of $CO_{2\ eq}$, the authors estimate transaction costs associated with the JI component of these projects (e.g., total cost of human domestic resources, annual implementation costs covering project assessment, monitoring, reporting, translation of reports into English, verification and certification) would remain below 5 percent of total host country revenues. It is recommended that an agency be established by the host country to carry out these activities.

The potential flow of investment related to JI for these “tradable” projects constitutes a weak incentive for the Czech Government when compared to the steady inflow of foreign direct investment to the Czech economy over the past several years. At prices of 5 USD/tonne of $CO_{2\,eq}$ the overall stream of carbon revenues generated by the “tradable” JI projects would be approximately 12 million USD/year, which is less than 1 percent of current total foreign direct investment. However, revenues from the sale of ERUs can be added to other, more important, incentives offered by the Czech Government to direct foreign investors.

The forestry and waste management sectors offer larger potential for JI projects in activities such as reforestation and sustainable forest management practices. The authors estimate about 4-5 million tonnes of CO_2 could be sequestered from reforestation of idle agricultural land. This would be equivalent to a 5-percent reduction of national greenhouse gas (GHG) emissions at a reasonable cost (approx. 10 USD/t of CO_2). Because of a dispersed land ownership structure (created by recent forest re-privatization), the authors suggest that a national Forest Fund could play a role in mediating between forest owners and foreign investors. The recently established national forestry certification scheme could also enhance the sequestration potential through sustainable forestry and climate-friendly use of timber.

In the waste sector, the EC Landfill Directive, which requires a substantial reduction in landfilling biodegradable solid municipal waste over the next decade, could lead to a reduction of over 1 million tonnes of CO_{2eq}. Only further incineration or composting effort — the definition of which will depend on detailed national implementation plans—could be considered additional. However, carbon finance could have a substantial impact on these projects, as sales from these reductions over the carbon market could generate up to 10 percent of current user charges for incineration, and the impact would be substantially higher for composting. Energy production out of landfill gases, when cost-effective, or at least flaring is also mandatory in the Landfill Directive.

Finally, the report examines the risks facing JI investors in the Czech Republic: both in terms of risks associated with underlying project performance and risks specifically introduced by joint implementation (e.g., non-compliance with Kyoto requirements by the Czech Republic, or changes in national baselines). The final assessment is that that multiple legal and institutional gaps will have to be eliminated by the Czech Government to make JI operational at reasonable transaction costs.

1. Introduction

The Czech Republic was the first country to host activities implemented jointly (AIJ) projects even before the first Conference of Parties of the UN Framework Convention on Climate Change (COP-1). In the first half of the 1990s, AIJ was viewed as a very promising mechanism, especially in terms of transfer of know-how and modern technologies. AIJ was expected to provide rapid assistance in solving severe environmental problems in the country, as well as a new form of foreign aid.

Key milestones for AIJ in the Czech Republic include the following:

- 1992. FACE (a Dutch foundation) the reforestation of Krkonose and Sumava Mountains damaged by emissions.
- 1993. Decin municipal heating plant modernization (coal-to-gas switching, combined heat and power (CHP), three U.S. power companies, approved as AIJ in 1998).
- 1995. Cizkovice cement factory modernization (Lafarge modernized the plant with fuel switching, recuperation of heat, upgrades to European standards, and reduction of emissions of other pollutants).
- 1996. Skoda-VW car factory modernization in Mlada Boleslav (modernization of old factory power plant, CHP, best available technology (BAT), coal-to-gas).
- 1999. Government adopts national strategy to mitigate climate change, in which Joint Implementation (JI), the Annex B project-based mechanism of the Kyoto Protocol, is mentioned among other mitigation policies and measures.

Expectations regarding the possible role of JI have now shifted with the growing complexity of JI requirements and rules (additionality, baselines, etc.) and a decrease in expected revenues from this mechanism. And the Kyoto mechanisms are now being reconsidered in light of the central issue of EU membership.

Because the baseline is partly determined by the regulatory requirements the project/activity currently faces or is likely to face in the future, EU accession must be taken into account when preparing the baseline scenario. The transposition of the EU legislation (not only environmental) into national laws and its subsequent implementation will have enforcement effects on GHGs emissions in terms of more stringent technical standards, emission limit values, new obligations to save energy, and the accelerating pace of phasing-out old, inefficient, and over-emitting technologies.

Scenarios of further environmental improvement based on the EU membership are expected by 2004.[1] And they must be also taken into account when defining emission baselines for JI projects. In coming years the introduction of higher technical standards and

[1] See European Commission Strategy paper 2001 posted at http://europa.eu.int/comm/enlargement/report2001/index.htm#Strategy Paper 2001.

"best available techniques" (BAT) will become obligatory.[2] This means that, to be additional, potential JI projects must meet increasing requirements, which may make JI investment more attractive in countries with substantially lower environmental protection.

In addition, multinationals like VW, Continental, Philips, and Siemens are either modernizing existing factories (usually as a result of privatizing large state enterprises) or launching green-field investment projects where obsolete technologies are replaced by more energy-efficient technologies. Total direct foreign investment reached 11.3 billion USD during 1990–98, with a sharp increase in 1999 (5.6 billion USD) and 2000 (4.5 billion USD) according to the Czech Chamber of Commerce. The services, banking, and insurance sectors received more than 50 percent of the total while the industrial sector received approx. 31.8 percent in 1999 and 34.5 percent 2000. The differential in labor costs between the OECD average and the Czech Republic is the major driving force. The country also offers a relatively developed infrastructure, an educated and qualified labor force, and proximity to the EU market.

Hence, JI incentives are marginal in the total investment picture, given that potential of JI is an order of magnitude lower than the investment figures. If the cost of emission reduction unit (ERU) was 5 USD/tC (18.3 USD/tCO_2), then the hypothetical value of total present emission reduction taken as a difference between the Kyoto target and real emissions is about 640 million USD/year.[3] Later, we will try to estimate what could be a tradable share of the emission reductions expected during the first Kyoto compliance period (2008–12).

The purpose of the present study is to examine the potential for tradable joint implementation projects (JI)—and factors important for JI investors or governments of JI investor countries—in view of the Czech Republic's impending membership in the European Union (EU). We first examine the potential for overall emission reductions during 2008–12 using emission scenarios in Section 2. Section 3 describes the new EU accession requirements, such as stricter emission limit values (ELVs), integrated prevention and pollution controls (IPPCs), energy saving regulations, and regulation in waste management interfering with JI "additionality."[4] Section 4 gives a quantitative estimate of the potential for JI. Section 5 covers transaction costs and political investment risks. The risks that must be covered by host country governments and JI investors using various instruments are summarized in Section 6.

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[2] Best available technique does not relate to production technology only. It also involves other aspects like management, maintenance, raw materials used, waste management, monitoring, and so forth.

[3] The present difference between the Kyoto target and present (1999) emissions is ca 35 million tonne/year which involves partially „hot air" reductions achieved without any specific policies and measures.

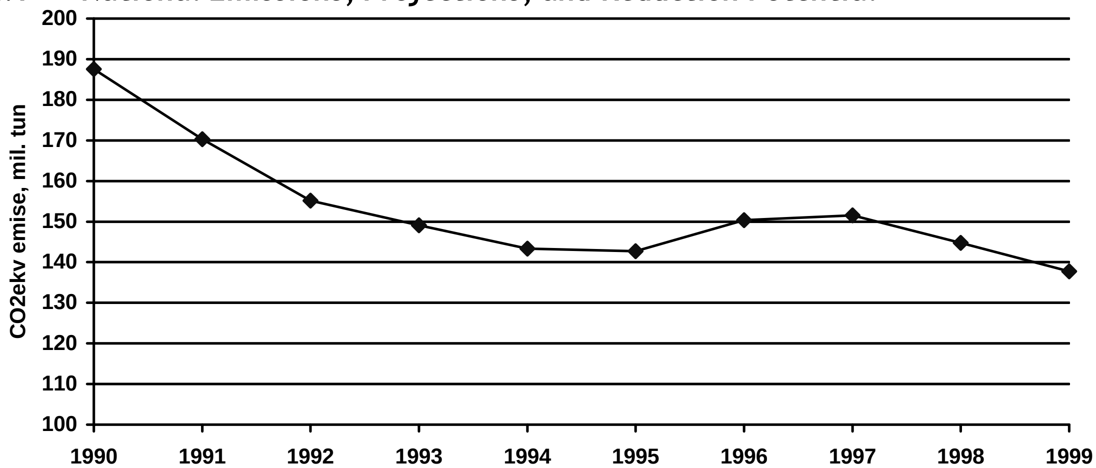
[4] In contrast with the early 1990s, JI activities are now strictly "additional," that is, it must be proved that the reduction in GHG emissions would not have occurred in the absence of the proposed activity (project). The Kyoto Protocol also states that emission reductions obtained through all flexibility mechanisms (including JI) shall be "*supplemental to*" domestic reductions. Although this requirement is not translated in an absolute cap, it may limit the demand for emission reduction units. In practice it means that reductions achieved by a concrete project are compared with a "project baseline." The difference between the real project performance and the baseline is the reduction effect of the project.

2. Reduction Potential

Total per capita and per unit GDP emission of greenhouse gases (GHGs) have decreased since 1990 (Figure 1). The Czech Republic adopted a – 8 percent reduction target with regard to 1990 levels at the Kyoto Conference in 1997 (COP-3), which represents an average objective of 172.5 million tonnes of CO_{2eq}/year between 2008 and 2012. If the per capita emission of GHGs were approximately 16 tonnes in 1990, at present they are below 12 tonnes. The decrease of emissions per GDP unit is about 2.5 percent annually, and we expect emissions in 2005 will be less than 0.80 tonne/1,000 USD (0.92 in 1998; OECD average 0.65).

Figure 1. Total GHG emissions in the Czech Republic, 1990–99

2.1 National Emissions, Projections, and Reduction Potential



Overall national emission data based on the national GHG emissions inventory (1999) are given in Table 1. Figure 1 shows that emissions stabilized at about 140 million tonnes of $CO_{2\,eq}$ by the end of the 1990s. This stabilization resulted from both a general economic transformation and the technical modernization of the energy, industry and residential sectors. The largest part of total GHG emissions is represented by CO_2 (86 percent); of which the energy sector emits 45.6 percent, industry emits 28.9 percent, agriculture and the tertiary sector together emit 14.8 percent, and transport emits 10.2 percent. The relative share of transport has grown by approximately 0.5 percent annually. Total emissions in 1999 are 26.6 percent lower than the base year of 1990.

Table 1. GHG emissions inventory, 1999

Sector	*National emissions, Gg*						
	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	SO_2
Total national emissions and removals	**117 692**	**517**	**26**	**390**	**709**	**244**	**269**
Energy	118 038	279	4	365	544	123	258
Fuel combustion - reference approach	*115 136*						
Sectorial approach	*117 501*	*21*	*4*	*364*	*543*	*122*	*253*
Energy industries	53 848	2	2	62	7	4	83
Manufacturing industries and construction	34 156	1	1	48	10	2	94
Transport	12 016	2	2	194	291	76	5
Other sectors	17 481	16	0	60	235	40	71
Fugitive emissions from fuels	*537*	*258*	*0*	*0*	*1*	*1*	*5*
Solid fuels	537	229					
Oil and natural gas	0	29	0	0	1	1	5
Industrial processes	**2 362**	**4**	**3**	**25**	**142**	**8**	**11**
Mineral products	2 362	0	0	12	7	3	4
Chemical industry		0	3	7	3	0	2
Metal production		4	0	5	130	1	5
Other production (food + paper)		0	0	1	1	5	0
Solvent and other product use	**336**		**1**			**113**	
Agriculture		**121**	**17**				
Enteric fermentation		85					
Manure management		35					
Agricultural soils and other N_2O emissions			17				
Land-use change and forestry	**–3 401**	**3**	**0**	**0**	**23**	**0**	
Waste	**357**	**111**	**1**				
Solid Waste Disposal on Land		82					
Wastewater handling		29	1				
Waste incineration	357						
Memo Items							
International Bunkers	539	0	0	3	10	4	0
Aviation	539	0	0	3	10	4	0

Source

2.2 Emission scenarios

This section presents two conceptually different sets of business as usual (BAU) GHG emission scenarios[5] for the Czech Republic based on two different macroeconomic scenarios: (1) the reference scenario (RS), and (2) the high economic growth rate scenario (HGS).

The reference scenario assumes the continuation of long-term economic trends in the Czech Republic. Based on the analysis of the trends in GDP growth during the last decades, an average annual GDP growth rate of 3 percent is used. This is equivalent to assuming that the current gap in income between the Czech Republic and most of the developed countries is preserved (the majority of these countries also expect the GDP growth rate in the range of 2-3 percent annually, and a 3-percent GDP growth rate is assumed for the United States for 2000-20[6]). Trends in GDP growth for the period 1991-2020 are presented in Table 2.

Table 2. Reference scenario for GDP growth (in basic prices) until 2020

Year	***Unit***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	
GDP in 1995 prices	Billion CZK	1355.1	1395.8	1437.6	1480.8	1525.2	1570.9	
Annual growth rate	%	3.5%	3.0%	3.0%	3.0%	3.0%	3.0%	
Year		***2006***	***2007***	***2008***	***2009***	***2010***	***2015***	***2020***
GDP in 1995 prices	Billion CZK	1618.1	1666.6	1716.6	1768.1	1821.1	1875.8	1932.0
Annual growth rate	%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%

Source: SRC International CS (2001).

The high economic growth rate scenario assumes that the present pro-active budgetary policy of the government can initiate high and stable economic growth in the range of 4-6.6 percent annually over the next two decades (Table 3).

Table 3. High economic growth rate scenario for GDP growth (in basic prices) until 2020

Year	***Unit***	***2000***	***2001***	***2002***	***2003***	***2004***	***2005***	
GDP in 1995 prices	Billion CZK	1355,1	1410,7	1486,8	1582,0	1686,4	1797,7	
Annual growth rate	%	3,5%	4,10%	5,40%	6,40%	6,60%	6,60%	
Year		***2006***	***2007***	***2008***	***2009***	***2010***	***2015***	***2020***
GDP in 1995 prices	Billion CZK	1887,6	1963,1	2051,4	2154,0	2272,5	2970,04	3881,72
Annual growth rate	%	5,00%	4,00%	4,50%	5,00%	5,50%	5,50%	5,50%

In accordance with the U.N. Framework Convention on Climate Change (UNFCCC), guidelines for development of National Communications[7] for each of these two BAU scenarios have been combined with the following three mitigation scenarios:

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[5] Developed by SRC International CS for the Third National Communication as laid out in document UNFCCC/CP/1999/7.

[6] Annual Energy Outlook 2001 with Projections to 2020, Environmental Impact Assessment (EIA), U.S. Department of Energy, December 2000.

[7] Document UNFCCC/CP/1999/7.

- Scenario "without measures" assumes that no specific measures aimed at reducing GHG emissions are promoted. Only replacement of current technologies at the end of their expected lifetime is assumed.
- Scenario "with measures" assumes that only the GHG emission reduction measures meeting the requirements of Czech Republic's legislation before January 1, 2001 are implemented.
- Scenario "with additional measures" assumes implementation of GHG emission reduction measures beyond those already in force on January 1, 2001. Some of these measures are currently in draft status. Others are simply foreseen to come into force before 2010.

The scenario "with measures" covers the emission reduction measures implemented between 1995 and 2000. They include fuel switching (stemming from the new clean air legislation and measures supported by the State Environmental Fund) and other measures like energy savings, promotion of renewables, and so forth, promoted by various national programs. The estimated emission reduction potential of these measures is about 10 million tons of CO_{2eq} per year (fuel switching alone accounting for about 4.2 million tons of CO_{2eq}).[8]

The scenario "with additional measures" includes the GHG emission reduction potential of the additional measures resulting from the programs and legislative changes accepted, prepared, or planned after year 2000. A conservative assessment of their reduction potential is about 6.4 million tons of CO_2. This amount of CO_2 emission is equal to the reduction potential of the measures with a simple payback period of less than 6 years (see Section 4).

All scenarios include the„profitable measures," measures with a payback period of less than 3 years. Indeed, these measures are attractive for the investors and we assume that they will be implemented without any external support. We estimate their reduction potential at about 5-6 million tons of CO_2 per year in each scenario.

Measures with lower economic attractiveness ("economic potential" in the classification of Section 4) cannot be implemented without significant external support. These measures were therefore not included even within the "with additional measures" scenario. We estimate the total reduction potential of these measures to be around 12 million tons of CO_2 by the year 2010.

The scenarios, which differ in choice and extent of mitigation measures, are prepared using the format of Intergovernmental Panel on Climate Change (IPCC) inventory guidelines for years 2000, 2005, 2010, 2015 and 2020. The summary of all the scenarios is given in Table 4, Figure 2 and Figure 3 below.

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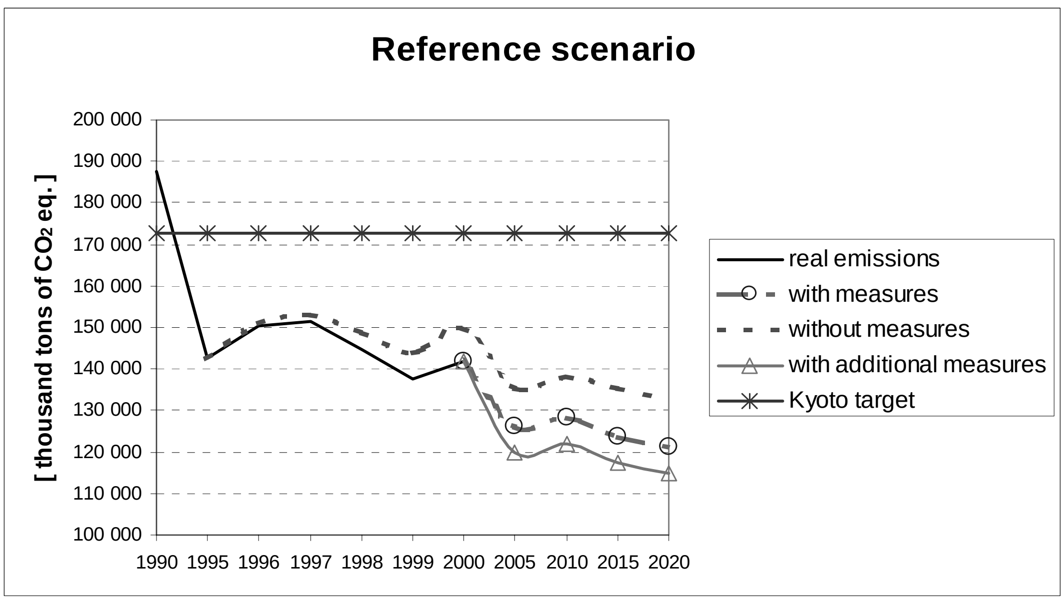
[8] When we evaluate the potential for further emission reduction projects (Section 4), we consider that these measures are already realized. Their reduction potential is therefore *not* included in the „real potential" in Table 7.

Table 4. Review of GHG emission scenarios
(million tons of $CO_{2\ eq}$)

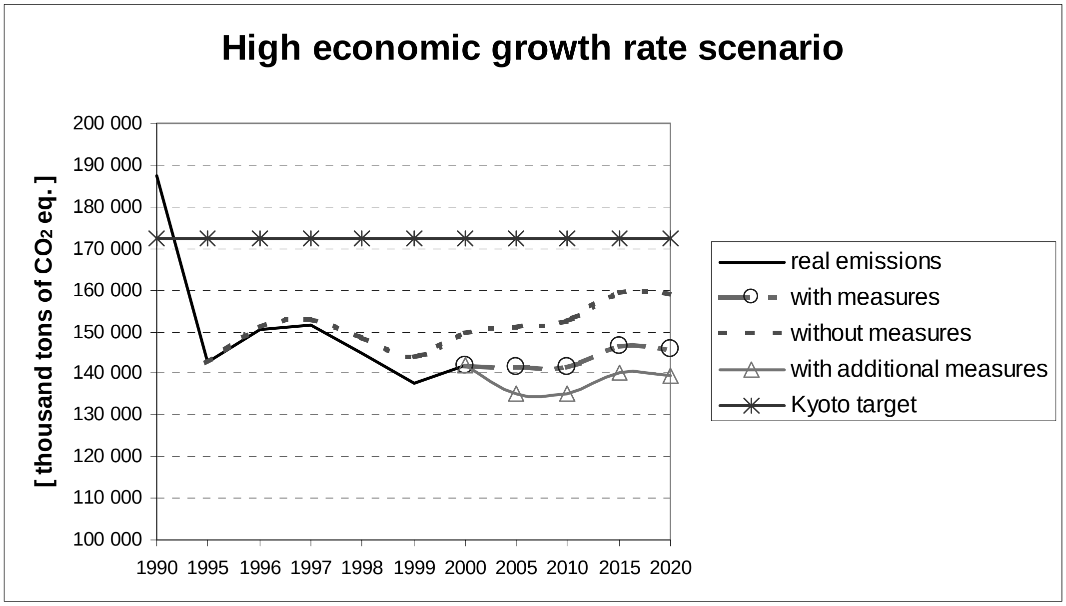
Year	*1990*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2005*	*2010*	*2015*	*2020*
Real emissions (inventory)	187.5	142.7	150.2	151.5	144.7	137.7	141.8				
RS (BAU)		142.7	151.2	153.2	148.8	144.1	149.8	135.3	138.4	135.5	133.1
RS with measures							141.8	126.4	128.3	123.8	121.2
RS with additional measures							141.8	120.0	121.9	117.4	114.8
HGS (BAU)		142.7	151.2	153.2	148.8	144.1	149.8	151.1	152.6	159.4	159.2
HGS with measures							141.8	141.5	141.7	146.6	145.9
HGS with additional measures							141.8	135.0	135.2	140.1	139.5

Figure 2. GHG emissions in the reference scenario
(thousand tonnes of $CO_{2\ eq}$.)



To assess the potential for JI projects, we must now make explicit the emission reduction activities which are mandatory under EU accession process, so as to determine what is the supply of truly additional projects.

Figure 3. Review of high economic growth rate GHG emission scenario (thousand tonnes of CO_2 eq.)



3. Joint implementation and European Union accession process

The EU accession process implies harmonization of all national legislation with EU legislation. In the following analysis, we will focus on EU and national legislation related to GHGs emissions (i.e., environmental protection and energy production/consumption). At the EU level three different instruments are used to reduce emissions from point sources:

- Prescriptive legislation contains minimum standards, e.g., emission limit values (ELVs) to be applied uniformly across the EU as in case of the directive on large combustion plants (LCP);
- Flexible legislation imposes additional site-specific or national rules, which will vary from one installation to another within the EU, e.g., directive on integrated prevention and pollution control (IPPC); and
- Voluntary and/or market-based instruments set the basic rules for operators who want to exploit voluntary or market opportunities, e.g., environmental management system or proposed GHG emission trading scheme.

In practice, emission limits, mandatory policies and measures, and product or technique bans must be harmonized before the Czech Republic becomes a EU member. The time frame for implementation is the subject of negotiations, but it is expected that there will be complete implementation of all measures, with exceptions for those with negotiated transition periods, before joining the EU (2003-04).[9]

The Czech Republic government intends to finalize the legal transposition before the end of 2002 and to implement the majority of policies and measures (or to achieve their implementation in negotiated regimes during the transition periods) before the date of the EU accession. According to this plan, all regulations impacting GHG emissions shall be effective by the January 1, 2003 at the latest. Although the date of the accession is not fixed yet, it is expected that the first round of candidate countries should join the EU in 2004–05. Thus, its highly probability that the Czech republic will be an EU member before the first Kyoto Protocol commitment period begins.

As a result, the "business as usual" scenario for the Czech Republic includes additional emission reduction policies and measures triggered by EU accession. In comparison with new independent states (NIS) and other Central and Eastern European countries (CEECs), which are not in the first wave of the EU accession,[10] JI additionality may thus become more difficult in areas influenced by new legal obligations. Moreover, the EC is currently preparing additional policies and measures with impact on GHG emissions. These will also become mandatory for the Czech Republic in the coming years.

Which potential JI projects could be impacted on by EU accession? In a previous study,[11] the authors had identified the industrial, residential sector, public sector, forestry and services sectors, as those with lowest marginal abatement costs and substantial theoretical JI potential.

In the following paragraphs the measures effecting GHG emissions are reviewed from the above viewpoint. The areas, in which existing or proposed EU environmental regulations could directly or indirectly (but substantially) influence JI in the Czech Republic (via stricter regulation), are as follows:

- Industry (Integrated Prevention and Pollution Control (IPPC) Directive)
- Waste management. Use of waste as an energy source, minimization of waste transport, reuse and reduction of landfill gas emissions (Landfill Directive)
- Energy sector. Large combustion plants (Large Combustion Plants (LCP) Directive)
- Residential sector. Energy efficiency of appliances

[9] Two negotiated transition periods relate to packaging and packaging waste (2005) and municipal waste water treatment (2010). Initially, the Czech Republic proposed seven transition periods (packaging and packaging waste, municipal waste water treatment, IPPC, nitrates from agriculture, quality of drinking water, industrial waste water treatment, and protection of endangered species and habitats, Natura 2000).

[10] The last annual assessment of EU candidates issued by the Commission (November 2001) does not expect Bulgaria and Romania in the first round (2004–05).

[11] DHV CR, SRCI and Carl/Bro, "Estimate of the economic costs for Reduction of Greenhouse Gas Emissions," Phare Project No.CZ9705-05-01-02, Prague 2000.

- Energy sector. Use of renewable energy resources (Directive on Renewable Electricity).

In subsections 3.1 to 3.4, we successively examine five areas influenced by the key EU regulations:

- Use of the "best available techniques" (BAT) *via* IPPC regulation in industry
- Energy saving in industry, residential sector, services and public sector (SAVE programs)
- Opening of energy market (Electricity and Gas Directives)
- Waste management related to the reduction landfill gas emissions, energy use of waste (Landfill directive), and
- Sustainable forestry including afforestation (enhancement of carbon sinks).

3.1 Best available techniques

The concept of best available techniques (BAT) is anchored in the IPPC Directive (96/61/EC). It must be transposed before 2002 into the national legislation of all EU candidate countries, and must be fully implemented by 2007.[12] Under the IPCC Directive, all target installations must submit an application and receive a permit (which is specific to the technical characteristics of the plant, an assessment of economic availability, and local environmental conditions). It is important to note that the IPPC Directive does not replace binding EU-wide emission limit values (ELVs), which are considered as a minimum requirement. The set of obligations defined by the permit (e.g., emission limits, energy and raw material consumption or corrective actions and measures taken at company level) are therefore dependent upon the interpretation of the fundamental concept of BAT by the regulator. Key language from the IPPC directive is presented in Annex 2.

This concept is defined in the IPPC Directive, Article 2(11):

1. "Best" means most effective for the environment as a whole,
2. "Available" means already developed and possible to implement under economically and technically viable conditions,
3. "Techniques" include both equipment and operational practice.

The key BAT term related to JI project baseline is **availability**. According to the IPPC Directive, "available" means "developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages ... as long as they are reasonably accessible to the operator." Availability is therefore a relative term, which shall be examined in a concrete situation by regulator.

[12] New installations (see further) will be regulated as of 30 September 2004.

The IPPC Directive covers large industrial installations (see Annex 2 for details) such as:

- Combustion plants with a thermal input exceeding 50 MW
- Mineral oil and gas refineries
- Coke ovens
- Coal gasification and liquefaction plants
- Metal ore roasting or sintering installations
- Installations for the production of pig iron or steel
- Hot-rolling mills
- Ferrous metal foundries, etc.

EC experts[13] have stressed that scenarios less stringent than BAT should *not* be used as a baseline for JI projects falling under the IPPC Directive. They argue indeed that baselines softer than BAT or obligatory emission limit values (ELVs) might be used as an excuse for candidate countries to delay investment in technical installations until after 2007 (deadline for full implementation of IPPC Directive). Baselines softer than BAT might also serve as a disincentive for investors to engage in needed high-tech projects, if cheaper credits were to result from low-tech investments.

The BATs related to specific technologies are overviewed in reference documents (BREFs) prepared by IPPC expert groups.[14] BREFs should be used as an input to the determination of BAT and setting operational conditions on individual basis.

BREFs, which summarize the information collected by panel of experts from various sources, are not legally binding and thus the emission levels characterizing BAT obligatory emission limit values (ELVs). The same holds for specific energy consumption expressed per unit of production, CO_2 emissions, etc. Since the BATs change over time, the reference documents will have to be reviewed and updated.

Implementation of BATs should generally lead to a reduction of the overall impact of the proposed project on the environment (and not only its impact on climate change). In certain cases, implementation of BAT can even lead to higher energy consumption (e.g., extra energy consumption of end-of-pipe denox or desulfurization installations).

BATs will introduce environmental requirements that exceed mandatory requirements. In the sectors covered by the IPPC Directive, projects which pass the additionality test are thus likely to yield less emission reductions than they would have without the directive because the baseline is now more stringent. Similarly, because of the

[13] See documents from the ECCP Conference in Brussels available at http://europa.eu.int/comm/environment/climat/eccp_report_0106.pdf

[14] Under coordination of IPPC Bureau, Sevilla (http://eippcb.jrs.es, eippcb@jrc.es)

higher minimal environmental standards required by the regulator, the costs of reducing emissions even further are likely to be higher than they would have been otherwise.

In short, the IPPC Directive may raise the costs of Emission Reduction Units (emission reductions produced through JI projects) in comparison to other countries like the NIS,[15] where such regulation is not expected to come into force during this decade. On the other hand, this should reduce baseline cheating (inflated baselines), increase public participation,[16] and enhance credibility of JI projects.

In practice, the regulator is expected to determine the BAT in the particular context of the country and site (local conditions). IPPC permits will be issued by regional authorities (principle of subsidiarity). When issuing the permit, the regulator must first negotiate with the operator on the BAT related to the installation operated under concrete technical and economic conditions. If the project involves <u>additional improvements,</u> going beyond the set of regulator's requirements (project baseline) to yield measurable reductions of GHG emissions, and only if this case, can emission reduction (Ers) be generated.

To conclude, the requirement to use BAT for project baselines does not exclude installations falling under IPPC regulation from JI projects, but it integrates the IPPC permitting procedure into the baseline estimation. IPPC regulation can also influence the crediting period of the project due to limited duration of the IPPC permit (permits are indeed periodically revised[17]).

One can therefore conclude that implementation of IPPC in major industrial installations (Annex 1 of the Directive and Annex 2 of this report for details), will influence the definition of the IPPC-JI project baseline. <u>The baseline shall be related to the content of the permit and the investor must prove that JI project goes beyond the requirements of the IPPC permit</u>. This will lead in some cases to a decrease in the reduction potential, which can be utilized via JI industrial projects. The overall potential and/or abatement costs will, therefore, be dependent upon the negotiation of the operator with the regulator on how to interpret the term "available" in their specific situation.

In the last draft of the Czech IPPC Act[18] (§ 4), the operator must submit the following: a comparison between the real performance if the installation and the BAT; a description of planned measures such as energy savings, emission prevention, etc.; and a

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[15] The same holds for CDM projects.

[16] Directive 96/61/EC on IPPC, Preamble Art. 23, „Whereas, in order to inform the public of the operation of installations and their potential effect on the environment, and in order to ensure the transparency of the licensing process throughout the Community, the public must have access, before any decision is taken, to information relating to applications for permits for new installations or substantial changes and to the permits themselves, their updating and the relevant monitoring data."

[17] Directive 96/61/EC on IPPC, Preamble Art. 23, „Whereas the authorization conditions must be periodically reviewed and if necessary updated; whereas, under certain conditions, they will in any event be re-examined;"

[18] See Parliament document No. 960/0, www.psp.cz

proposal of binding operation conditions. Accordingly § 13 and 14, the competent authority shall lay down in the permit among others:

- individual emission limits
- conditions to protect surrounding environment and human health
- conditions for effective use of energy and raw materials
- measures to prevent long-range transport of pollutants
- monitoring and procedures to assess compliance with the binding conditions.

The integrated permit is valid for 8 years, during which it must be checked by the authority at least once and eventually modified (§18). All installations submitting construction applications after September 30, 1999 shall be subject to the permitting procedure prior to September 30, 2004. This also concerns major changes of existing installations(§18). It is therefore evident that all IPPC installations projected now will be regulated by the IPPC Act as of 2004.

3.1.1 General binding rules

Article 9(8) of the IPPC Directive allows for Member States to use “general binding rules” (GBRs) in lieu of certain parts of specific permits, as long as the integrated approach is maintained and the requested level of environmental protection is ensured. However, the Directive does not provide a definition of a GBR. Three interpretations are plausible:

- A statutory set of standard conditions applying to the entire operation of an installation,
- A statutory set of standard conditions applying to one or more aspects of the operation of an installation, and
- A statutory set of minimum conditions established at a national level and binding for regional regulators.

The need to ensure equivalent, high-level environmental protection means that GBRs cannot be used in cases where there are particular local environmental sensitivities: those can only be assessed using an individual permitting process based on BATs. Thus GBRs are appropriate only where emissions do not lead to local problems or where interactions with individual media are predictable. GBRs could be therefore used to set JI project baselines for broad range of IPPC-regulated installations. In this case, GBRs would not interfere with another part of the permit unrelated to GHGs emissions like local air pollution, water pollution, waste management, prevention of major industrial hazards, chemical management, etc. GBRs have a number of advantages; once developed, they can simplify the permit procedure for the regulator and industry.

For more information, see a recent report which assesses the potential use of general binding rules (GBRs) in the implementation of the IPPC Directive.[19] Finally that using GBRs would certainly make the whole process of JI crediting more transparent (uniform requirements for whole categories of large installations) and the baseline rules would not be negotiated on an individual basis.

3.1.2 IPPC directive and EU emission trading

Similar interference is now emerging between IPPC and the EU-wide emission trading scheme currently under preparation.[20] Recent discussions of the EU pilot trading scheme,[21] have emphasized the links between the draft proposal on EU trading and the IPPC Directive. In particular, the draft proposal on trading makes provisions for the following coordination. When applying for an IPPC permit, an operator could also obtain the necessary greenhouse gas emissions permit by supplying the additional information required. The most obvious difficulty is that the IPPC Directive requires limits on all pollutants to be emitted when using BAT. Therefore, the current draft proposal states that an installation covered by the emission-trading scheme should not have an absolute limit set by IPPC permit on direct emissions of GHGs.

An amendment to the IPPC Directive will therefore be required, to make it explicit that, if GHGs emission from installations are covered by the drafted Emission Trading Directive, then ELVs for GHGs should not be set under the IPPC permitting procedure. This provision may also eliminate interferences between the JI baseline definition and IPPC permitting procedure. But whether JI specific demands are also taken into account will depend on the precise wording of the mentioned amendment to the IPPC Directive .

3.2 Energy savings

An important instrument to limit CO_2 emissions transposed from the EU legislation is the SAVE Directive 93/76/EEC (key articles of this directive are reproduced in Annex 2 and 3). According to Article 1 of the directive, its purpose is "the attainment by Member States of the objective of limiting carbon dioxide emissions by improving energy efficiency, notably by means of drawing up and implementing programs" in the following fields:

- energy certification of buildings
- billing heating, air-conditioning and hot water costs on the basis of actual consumption
- third-party financing for energy efficiency investments in the public sector
- thermal insulation of new buildings

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[19] IMPEL Report of General Binding Rules (2001), see pdf-format copy available at http://www.europa.eu.int/comm/environment/impel/gbr.htm

[20] See draft Directive establishing a framework for greenhouse gas emissions trading within the EC and amending Directive 96/61/EC, COM(2001)581, October 23, 2001.

[21] See EU Environmental Issue Manager, October 2001, Eamon Bates, Brussels.

- regular inspection of boilers
- energy audits of undertakings with high-energy consumption.

Programs can include laws, regulations, economic and administrative instruments, information, education and voluntary agreements whose impact can be objectively assessed.

The following list of Czech legislation adopted in 2001 shows how strongly the SAVE Directive (and other energy-related EU legislation) has impacted domestic legislation:

- 150/2001 Coll., Decree of the Ministry of Industry and Trade laying down minimum energy efficiency requirements for generation of electricity and heat energy;
- 151/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules on energy efficiency in distribution of heat;
- 152/2001 Coll., Decree of the Ministry of Industry and Trade laying down rules for heating and supply of heat service water, indicators of heat consumption for heating and for preparation of hot water, and the requirements on internal heating plant equipment to regulate delivery of heat energy to final consumers;
- 153/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules for determination of energy efficiency in transmission, distribution, and internal distribution of electric energy;
- 195/2001 Coll., Government Regulation laying down detailed rules for the content of spatial energy planning;
- 212/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules for preparation and implementation of combined electricity and heat production;
- 213/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules for energy audit;
- 214/2001 Coll., Decree of the Ministry of Industry and Trade on delimitation of renewable energy sources;
- 215/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules for labeling the energy consumption of energy appliances and for establishing technical documentation, as well as minimum energy efficiency for electric appliances placed on the market; and
- 291/2001 Coll., Decree of the Ministry of Industry and Trade laying down detailed rules for energy efficiency for heat consumption in buildings.

All mandatory energy saving measures in national legislation or embedded in national programs formulated according to the SAVE Directive should be taken as a part of the business-as-usual scenario. The only question is whether, in the absence of direct reference to the Directive in the national programs or in the absence of programs required by the SAVE Directive, the projects implemented in the above mentioned areas could receive JI status. In such a case, additionality depends on a transparent description of all relevant programs launched by the Czech Government.

3.3 Opening energy markets

Other EU Directives that may influence the JI market include the Electricity Directive[22] and the Gas Directive, which set the rules and timeframe for opening domestic electricity and gas markets to foreign competition. The Implementation of the Electricity Directive within the EU has had a strong impact on the prices of electricity. In general, prices for end-users have dropped by up to 30 percent. Correspondingly, the buy-back tariffs from IPPs have dropped. As a result, the economic viability of both energy efficiency projects on energy supply and energy demand sides were highly impacted, and many of them were stopped (e.g., small and medium-scale CHP plants).

In the Czech Republic, the electricity market will be opened step by step starting January 1, 2002[23] (see Table 5).

Table 5. Major steps proposed for opening power market in the Czech Republic

Date	*Consumer capacity (single meter) GWh*	*Producer capacity MW*	*Milestones*
January 2001			New Energy Act in full power
January 2002	>40	>10	
January 2003	> 9	100%	Removal of subsidies
January 2005	> 0.1	100%	
January 2007	100%	100%	

Source:

It is expected that the electricity prices for large and medium consumers will drop, as it did in EU countries, due to strong competition. Only in the case of small consumers (households) should prices continue to grow due to the step-by-step elimination of cross subsidies. It is expected that only power plants with low operating costs will be able to compete on the market in next few years. Many projects that show economic viability now (CHP plants, renewable energy sources) may become economically non-competitive when electricity prices drop. Only policy instruments promoting energy efficiency and renewables (investment grants, preferential access to grid, higher buy-back tariffs, etc.) can maintain economic viability for these projects.

Of these measures, the proposed increase of buy-back tariffs for electricity from small and medium-size CHP plants by 30 percent in 2002 seems to be the most promising. In the case of renewables, the increase would be even higher (100 percent for biomass, 150 percent for wind, and 300 percent for photovoltaic cells). Similarly, gas prices have a decisive impact

[22] Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity.

[23] Act 458/2000 Coll., Energy Act.

on coal-to-gas fuel-switching projects. Even if gas prices are not expected to drop as much as electricity prices, some reduction could also take place for large consumers. As a result, the use of gas in power and heat production is expected to grow. In addition, possible reduction of support provided by the government to the coal industry and the implementation of a carbon tax would increase the price of coal, thus promoting fuel switching even more.

3.4 Waste management

The two main sources of GHG emissions in the waste management sector are (1) CO_2 emissions resulting from waste incineration; and (2) CH_4 emissions from landfilling of biodegradable waste (landfill gas).

Approximately 0.36 million tons of CO_2 and 82 thousand tonnes of CH_4 were emitted as a result of incinerating and landfilling solid waste in 1999. Using a Global Warming Potential of 21 for methane, total emissions from waste management were approximately 2.1 million tonnes of $CO_{2\ eq}$ in 1999.

A new framework national legislation, Act No. 185/2001, Coll. on waste management has recently been introduced. The Act harmonizes the Czech legislation with requirements of Directives 75/442/EEC on waste and 1999/31/EC on landfills (Landfill Directive). See key articles in Annex 3 to this report.

According to Article 1 the aim of Landfill Directive is, "by way of stringent operational and technical requirements on the waste and landfills, to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life-cycle of the landfill."

Two provisions of the Landfill Directive have particular importance for GHG emissions:

- First, the Landfill Directive limits the amount of biodegradable waste that can be disposed in landfills (using 1995 as a reference year).
- Second, the Directive requires collection of landfill gas. Precisely, "landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared" (Annex of the Directive, Article 4).

Since these projects (leading to the implementation of the above requirements) cannot pass the additionality test, they are excluded from JI. The above requirements will be in force in the Czech Republic by January 1, 2002. In the following paragraphs, we estimate the impacts of these new regulations on GHGs emissions related to waste management.

We first roughly estimate the amount of solid municipal waste (SMW) to be diverted from landfilling as a result of the Directive. A projection of SMW generation until 2010 is presented in Annex 6 of this report. According to this projection, the estimated BAU generation in 2010 is ca 625 kg/inhab., which corresponds to an annual growth of 3.9 percent.

The landfill directive obliges the Czech Republic to landfill only 75 percent of biodegradable waste in 2010 compared to 1995 disposal, that is ca 108 kg/capita. In absolute terms, 1.52 million tons of biodegradable SMW must thus be either composted or incinerated. If we also make the assumption that the content of biodegradable waste increases linearly from its present 40 percent value to 50 percent in 2010 (due to decrease of ashes from coal home heating resulting from gasification), then the amount of biodegradable SMW to be incinerated or composted will grow up to 1.82 million tons.

The installed annual capacity of SMW incinerators (Praha, Brno, Liberec) is 640 thousand tonnes. Consequently, an additional capacity for incineration and composting of 0.9 to 1.2 million tons of SMW must be built by 2010, which represents 4–6 large SMW incinerators and a dozen composting facilities. The separate collection of biodegradable parts of SMW must be implemented in large municipalities to keep user charges at lower levels.

The amount of biodegradable waste landfilled should be further decreased to 77 kg/capita (till 2013) and 50 kg/capita (by 2020). If we assume biodegradable SMW generation grows by another ca 15 kg/capita over the 2010–20 period, a total of 220 - 250 kg/capita of biodegradable SMW will have to be incinerated or composted by 2020[24], that is 0.4 to 0.7 million tons of biodegradable SMW to be further excluded from landfilling between 2010 and 2020.

To conclude, a substantial investment in SMW management has to be undertaken in coming years as a result of EU accession to decrease landfilling of biodegradable SMW. These measures will decrease emissions of landfill gas by about 50-60 percent by 2012 (compared with 1995). The large landfills will have to be equipped with collection systems to reduce landfill gas emissions to the atmosphere. As construction costs of incinerators are estimated to 200–250 mil. USD per million of tons/year of SMW, an investment in the range of 250–400 mil USD is expected in coming decade in the waste management sector in the Czech Republic. All these investments will be induced by the EU accession and *stricto sensu* these projects will therefore not meet the requirement of JI additionality. Only investment in incineration or composting beyond these requirements, the nature of which will depend on the implementation plans to be adopted by the Czech Government, could be considered additional.

As a result of the investment into incinerators, the landfill gas emissions should be reduced to approximately 40 thousand tonnes/year while emissions of CO_2 reach 1 million tonnes/year, which amounts to a total of 1.8 million tons of $CO_{2\ eq}$ in 2010.[25] In the absence of the EU Acquis implementation, the emissions would be approximately 3 million tonnes of $CO_{2\ eq}$. If the landfill gas emissions avoided could be traded as an additional revenue of

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[24] We estimate a steady population of 10.3 million inhabitants.

[25] Additional emission reduction results from substitution of fossil fuels by energy use of waste (but is not considered in our estimates).

incinerators at 5 USD/ton of $CO_{2\ eq}$, the user disposal charges could be lowered by 5–10 percent.[26]

High costs of incineration are due to the strict emission limits for dioxins and dibenzofuranes (PCDD/PCDF) set recently by EU legislation. On the other hand, the unit costs of composting or anaerobic digestion are expected to be orders of magnitude lower. However, it should be kept on mind that only a part of SMW is compostable and that composting requires total separation of toxic waste streams like batteries, solvents, paints, etc.

Last, the Landfill Directive requirements leave open the possibility that some collection of landfill gases to produce energy projects could be additional if this option is not cost-effective in the first place. However, according to the Directive requirements, flaring should then be considered the baseline.

3.5 Forestry

Approximately 33 percent of the Czech Republic is covered by forests (2,637,000 ha) that have been cultivated for several centuries. Conifers prevail and 1,410,000 ha (54 percent) are planted as spruce monoculture for plywood and pulp. Pine and larch are the other main species. In recent decades, Czech forests have been massively hit by SO_2, NO_X, and dust emitted by large combustion plants (LCPs) (mostly using brown coal with a high sulfur content). But despite these damages, the standing stock has increased during the 1990s to reach 250 m^3/ha, which is the fourth highest value in Europe.[27]

Nearly all forests in the Czech Republic were state-owned (95.8 percent) until the end of the 1980s. A recently launched re-privatization program aims at giving these forests back to their original private owners. Before 1945, only 18.3 percent of Czech forests were state-owned. Today (2000), State forests represents 63.1 percent of total surface, 13.6 percent are municipal forests (commons), and about 23 percent are privately owned. The ownership of former church forests (6.5 percent of total) is still to be decided. More than 90 percent of municipal and private individual forest owners have less than 10 hectares.[28] State forests also include forests in military areas, national parks, and protected forest ecosystems. Foreigners are excluded from owning agricultural and forest land.

Forest management is regulated by Act No. 289/1995 Coll. on forest (Forest Act), as amended by Act No. 67/2000 Coll., and several implementing decrees. Government Decree No. 193/2000 Coll. stipulates deadlines and procedures for forest inventory to be carried out

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[26] Energy utilization of waste is not assumed in this rough estimation, in which collection and operational costs are not included; energy utilization may reduce the abatement costs by 5-10 percent because user charges are about 100–120 USD/tonne of waste incinerated.

[27] All statistical data used in this chapter are taken from „Zelena zprava" (Green Report) submitted anually to the Government by the Ministry of Agriculture (see http://www.uhul.cz/zz/) and Environmental Performance Reviews - Czech Republic, OECD, Paris, 1999.

[28] The average size of publicly owned forests is 484 hectares; 55.3 percent of all public forests is less than 10 hectares. Average size of private forest is 3 hectares (87 percent of all private forests).

during 2001–04. Since 1998, forest management data collection is mandatory[29] for private forests larger than 200 ha.

The Forest Act obliges forest owners to carry out reforestation within two years of felling. Limited subsidies are available for reforestation and following care. Pest control, adequate pruning and thinning are additional obligations stemming from the Forest Act. The amending Act No. 67/2000 Coll. lays down, among others things, penalization for breaches of the law. The next major amendment of Forest Act is expected by 2005.

The framework of existing forest legislation, which is based upon the concept of sustainable forestry, may make it more difficult for JI programs focused on reforestation and forest management in areas legally declared as forest to pass the additionality test. On the other hand, the additionality of reforestation over unused agricultural land is generally out of question (provided active reforestation sequesters carbon more rapidly than natural re-growth) and this activity is therefore suitable for JI projects.

Forestation of land currently used for agriculture (arable land and pastures) is a voluntary activity supported by a program of the Ministry of Agriculture. Annually, the Ministry allocates grants for forest regeneration and protection amounting to over 300 million CZK. Another 250 million CZK is allocated to private and municipal forest owners to enhance non-wood functions of the Czech forests. Annually, about 25,000 ha of forest are regenerated.[30]

Extent of reforestation of forestland is given in Table 6. Artificial forestation prevails (85–95 percent of total area reforested, cf. columns 4 and 5) but about 1/4 to 1/3 of the area is to be reforested repeatedly due to damages caused by pollution, pests, herbivores and weather.

Table 6. Deforestation and reforestation in the Czech Republic
(1000 hectares)

Year	*Forestland area deforested on January 1 of given year*	*Area deforested during that year*	*Artificial reforestation during that year*	*Total reforestation during that year*
1990	38.9	34.3	33.6	35.6
1995	33.2	31.7	30.1	32.5
1998	24.9	26.4	24.3	27.6
1999	23.6	23.5	23.2	26.3
2000	20.8	23.8	21.9	25.8

In prevailing Czech conditions (cool temperate forests) 2–3 tonnes/ha of dry biomass are accumulated every year, which corresponds to a sequestration rate of 1–1.5 tons of C/ha

29 Previously the data were gained on basis of mandatory statistical sampling
30 MoE, Annual State of the Environment Reports, Prague since 1994.

(conversion factor of 0.5).[31] Maximum storage capacity of the European cool temperate forests is estimated at about 300 tons C/ha (20–30 tons of litter, dead trees and debris, 100–160 tons of above and below ground vegetation, and 120–140 tons of soil organic carbon). The above estimates are valid for mature cool temperate forests in an equilibrium state (more than 150 years old). Compared with arable land or pastures the carbon storage capacity of forest is more than five times higher.

Using the average costs of forestation[32] and expecting that an increase of carbon accumulation will be 90–140 tC/ha after 100 years, the cost of carbon sequestration is 700–1,000 CZK (ca 20–25 USD) per tonne of C, which corresponds to 5–8 USD/t of CO_2. It is expected that the forestation costs may grow slightly in this decade (up to 10 USD/t of CO_2) due to increasing costs of labor, energy, and biocide preparations.

Comparing these abatement costs with other alternatives we recommend financially sustainable forest management aimed on strengthening sequestration, storage, and substitution practices.[33] These practices include options such as afforestation of non-forest land, regulation of felling, protecting forest reserves, controlling fire and pest outbreaks, and so forth. These measures would increase the carbon accumulating capacity of the Czech forests. In addition, substitution practices aiming at increasing use of wood as a substitute of fossil fuel based energy and products (building materials, furniture etc.) could be included.

Present annual carbon storage capacity is estimated at only 3.8 million tonnes of CO_2, which corresponds to approx. 1/3 of the amount calculated using standard threshold values.[34] Given the improving health of the Czech forests, which results from the dramatic decrease of sulfur dioxide, nitrous oxide and micro-particulate emissions from LCPs (which occurred during the 1990s), an increase of annual sequestration capacity can be expected.[35] Another 1.5–2.5 million tons of carbon dioxide could be sequestered annually from forestation of 0.5 million hectares of idling agricultural land (increase by about 20 percent). This would represent a 1–2 percent reduction of total national GHG emissions obtained at reasonable costs (approximately 10 USD/t of $CO_{2)}$.

The sink potential of forests is even greater in other EU candidates like Bulgaria, Hungary, Poland, Romania, Slovenia, and the Slovak Republic. In contrast with other mitigation activities, the conversion of unused agricultural land into forest area is not regulated by EU legislation. In the Czech Republic the decision to convert land to forest depends on the landowner and there is thus no piece of legislation which would make such

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[31] IEA, Revised 1996 Guidelines for national Greenhouse Gas Inventories, Reference manual, Ch. 5 Land use change and forestry, 1996.

[32] Total cumulative average costs of forestation, pest protection, thinning, and so forth is 2.0 thousand USD/hectare (see Green Report, 2000) over the 100 years.

[33] IPCC Technical paper, Chapter 7, Forest Sector (http://www.gcrio.org/ipcc/techrepI/).

[34] Recommended in the Revised 1996 Guidelines for National GHGs Inventories, Reference manual, Ch. 5, Land use change and forestry, IEA 1996.

[35] About 5 percent increase of annual growth increment has been observed since 1980 (see Green Report, 2001).

projects non- „additional." Regulation 1257/99/EC simply recommends state support for conversion of idling agricultural land to forests.[36] Generally, EU candidates must limit the shares of their agriculture in GDP as well as volume of labor employed in this sector to comply with the EU agricultural policy.

As the parts of the forest once owned by state have been privatized over the past decade, and as the ownership is very diverse—which is also true for unused agricultural land—the rational way to increase sink capacity in CEECs is to create a special "national carbon forest fund" which would be a partner of JI investors. A large and diversified portfolio of hundreds of medium and micro-sustainable forest projects could reduce risk for investors as the fund can guarantee generation of credits better than an individual owner. We have proposed elsewhere[37] using the existing subsidy system of the Ministry of Agriculture (Podpurny a garancni rolnicky a lesnicky fond, a.s.) for this aim. However, this system needs to be confronted with the existing EU regulations.[38] In this regard, forest certification seems to be a suitable tool for sustainable, long-term forest management, which should cover monitoring, validation, and certification of JI forest projects.

The Czech Republic launched a forest certification program in 1996. Two years later, the National Certification Center was established and started to implement a national certification scheme at the individual forest-owner level. This system is based upon national legislation, administration practices including enforcement, national forest inventory (database), information system, and forest planning. After joining Pan European Forest Certification Scheme (PEFC), the Czech Republic started with modifications of the national certification system to reach full conformity with PEFC requirements.

This approach may substantially reduce JI transaction costs. In the case of small individual owners, costs would be fully covered by the proposed forest fund. For small owners, in particular, participation in JI activities could thus result in improved forest management and a sustainable sink capacity. Costs related to reforestation, pest control, insurance, and so forth could be also fully or partially covered by the fund. This legal, financial, and technical assistance related to JI, which would not diminish regular revenues from timber production, will therefore increase attractiveness of reforestation for small and medium landowners and farmers (incl. municipal commons).

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[36] Commission Regulation 1257/1999/EC on the rural development subsidy to be advanced from the European Agricultural Orientation and Guarantee Fund (EAGGF) and on the modification and withdrawal of certain Regulation s, Chapter VIII. Forestry.

[37] DHV CR, SRCI and Carl/Bro, "Estimate of the economic costs for Reduction of Greenhouse Gas Emissions," Phare Project No.CZ9705-05-01-02, Prague 2000.

[38] See Commission Regulation 2080/92/EEC on the introduction of community subsidy system in relation to forestry measures taken in agriculture, Commission Regulation 1054/94/EC on the development of detailed regulations on the financial control of programmes approved on the basis of the Commission's Regulation 2080/92/EEC, and Commission Regulation 1610/89/EEC on the definition of the measures to be taken for the execution of Regulation 4256/88/EEC in the Community's agricultural areas to develop and put the forests to optimum use.

One can conclude that forestry sector in Czech Republic (and other CEECs) deserves attention with respect to JI. A national carbon forest fund in combination with a PEFC scheme could integrate small forest owners and reduce transaction costs. Finally, the transaction costs and risks related to individual small forestry projects can be reduced via a project portfolio that diversifies risk.

3.6 Incoming EU legislation related to JI

Beyond the *Acquis*, which is transposed at present, future EU legislation—currently at various drafting stage—will also be transposed and implemented by candidate countries. As the information on legislative activities of the European Community is publicly known, the crediting time for JI projects should not continue in principle when an individual measure is translated into national laws.[39] It means that the BAU scenario in candidate countries is a dynamically changing set of legal requirements and obligations stemming from the association agreements signed between the EU candidates and the European Community. This makes a substantial difference in comparison with NIS where such rapid legal changes do not occur.

The following EU policies and measures are overviewed in Report of European Climate Change Program (ECCP).[40]

- Framework Directive for a Community Greenhouse Gases Trading Scheme
- Bio-fuel Directive
- Directive for Promotion of Renewable Energies
- Directive for Energy Performance of Buildings
- Directive on Energy Efficient Public Procurement
- Amended SAVE Directive 93/76/EEC
- Framework Directive on Fluorinated Gases.

Table 7 reviews the piece of legislation, at different stages of drafting, which may come in force with substantial probability before the first commitment period of the Kyoto Protocol. Strengthening ELVs for LCPs may cause phasing-out or reconstruction of power plants, which as "new installations" will be regulated under IPPC (with BAT as a project baseline).

If the Czech Republic adopts a national binding target for share of renewables in the national energy balance, then all projects implemented to reach this target become part of the BAU and are therefore not fully additional. Energy saving in newly built or reconstructed public buildings such as schools, hospitals, offices, etc. will be, to a growing extent, a part of

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[39] See also "Climate relevant pieces of the Acquis Communautaire," Information sheets, EC, DG Env, January 30.

[40] European Climate Change Programme, Report, June 2001.

BAU as they would meet requirements of Directives regulating energy performance in buildings (see above new regulations implementing SAVE Directive).

Table 7. Directives with future effect on JI in the Czech Republic

Directive	*Contents*	*JI impact*	*Time horizon*
COM(98)415	Strengthening ELVs for NOx,SO2 and dust. Three categories of sources (pre 1987, 1987-2003, post 2003). Sources 50 MWth and more.	medium	2003
COM(00)279	The proportion of renewable energy should be doubled from 6 to 12 percent of primary energy supply by increasing the share of electricity generated from renewables (non-fossil) from 14 to 22 percent by 2010. Indicative or binding national targets.	large	2003
COM(99)125	National target for VOCs decreasing EU-wide. VOC emissions to 60 percent of 1990 level by 2010. Obligation to draw up a national program.	marginal	2005
COM(01)226	Energy efficiency in buildings via minimum energy performance standards (new buildings, renovation, boilers, heating, cooling) via audits and certification.	large	before 2010
93/76/EEC, SAVE and prepared amendment	Strengthening of existing 93/76/EEC and extending its scope to small-scale renewable energy use, transport efficiency, lighting, small-scale cogeneration, and so forth.	large	2005

There are other policies and measures "in the pipeline" according to the ECCP, such as:

- Adaptation/revision of the IPPC Directive
- Combined heat and power (CHP) Directive
- Voluntary measures to reduce methane emissions
- Directive on energy services
- Framework directive for minimum energy efficiency standards for electrical equipment.

As the legislation in the EU is prepared several years in advance and as there are usually two years for transposition and implementation on national level, none of the above policies and measures is likely to be in force during the pre-accession period (until the end of 2004), even in the most advanced EU candidate countries.

4. Estimation of potential supply of JI projects with EU accession

This section re-examines the potential for JI projects in different sectors taking EU accession into account.

In the Czech Republic as in other CEECs the emission reduction potential in different sectors has been estimated using MARKAL modeling.[41] The first estimate of the total emission reduction potential for the Czech Republic—carried out for the first National Strategy Study (1997)—is revised in the present study. The authors compare the reduction potential reported in National Strategy Study (NSS) on JI with the latest development in this area, and how much of this potential has "high" additionality, meaning that it there is a high probability the activity would still be additional in a medium time horizon (2015).

The steps followed in this section are:

1. Categories of emission reduction measures are identified. These measures go beyond the requirements of the environmental policies that have been adopted in the Czech Republic from 1995 to 2000.

2. Attached to each of these measures is an emission reduction potential (in tonnes of CO2eq/year) and an intrinsic economic evaluation. Namely, the evaluations fall in one of the following five categories: simple payback period ≤3 yrs, simple payback period ≤6 yrs, NPV (at 10 percent discount rate) >0, NPV (at 5 percent discount rate) >0, economically non-viable measure.

3. It is assumed that only a fraction of this "technical potential" is feasible. This fraction depends n the penetration potential of each category. This "real potential" represents about 38 percent of the "technical potential" (24 MtCO2/yr, Table 8).

4. Part of this potential, the most attractive slice (measured with the simple payback period ≤3yrs), is assumed feasible in any case (part of the BAU scenario). The remainder (18.5 MtCO2eq/yr, Table 9) is the "JI potential."

5. Measures that fall into the BAU scenario because of EU accession-related regulations are excluded from this potential. The remainder (13.3 MtCO2eq/yr) is the "real JI potential" (Table 10).

6. Last but not least, the "tradable JI potential" is estimated as the sum of projects with GHG emission reduction potential greater than 1,000 tons of CO2 per year. These measures (projects) cover about 18 percent of the previous "real potential for JI" or 2.4 MtCO2eq/yr.

[41] SRC International, Prague, which is a leading company in this type of modeling in CEECs revises regularly its database of measures to recalculate emission scenarios and MACs.

4.1 Construction of the technical potential

STEP 1. The GHG emission scenarios prepared using the MARKAL model[42] for the Third National Communication to the Parties to the UNFCCC are based on a database (catalogue) of individual technical measures for the GHG emission reduction, namely CO_2 emission reduction. For each scenario, the MARKAL model then computes which measure is assumed to be implemented based on an assessment of their economic attractiveness, using minimization of total energy costs as a basic criterion. We assume the economically viable measures—not the ones with largest emission reduction potential—are implemented.

The emission reduction measures are part of a more general catalogue of energy saving measures prepared by SRC International CS for the main sectors of the economy (for more details see "Annex 5: Catalogue of energy savings measures and methods for the estimation of potentials"). The measures are selected for the following sectors:

- Residential sector
- Transport
- Industry
- Tertiary sector
- Agriculture
- Municipal energy sources
- Renewable energy sources.

For each measure the following information is provided:

- Total number of potential installations
- Emission reduction potential per unit
- Investment and operation and maintenance costs per unit
- Energy and financial savings per unit
- Technical lifetime.

Based on the above information, the economic evaluation of the individual type of measures is carried out.

STEP 2. Individual measures are categorized according to their economic effectiveness into the following 5 groups:

1. Market potential: Simple payback period ≤ 3 years (measure with the simple payback period shorter than its lifetime and shorter or equal to 3 years)
2. Market potential: Simple payback period ≤ 6 years (measure with the simple payback period shorter than its lifetime, longer than 3 years and shorter or equal to 6 years)

[42] The MARKAL model is presented in details in Annex 1.

3. Economic potential: NPV (10 percent) > 0 (measure with Net Present Value greater than zero at the 10 percent discount rate and with simple payback period longer than 6 years)
4. Economic potential: NPV (5 percent) > 0 (measure with Net Present Value greater than zero at the 5 percent discount rate and less or equal to zero at discount rate 10 percent)
5. Technical potential (all technically feasible measures without assessment on their economic viability)

Technical reduction potential of all selected measures is about 62 million tons (Mt) of CO_2/year. The largest share of this technical potential consists of measures that are not economically viable.

Table 8. Split of the technical potential of CO_2 emission reduction measures by category

Economic class of the measure	*Reduction potential (Mt of CO_2/year)*
Economic potential: NPV(10 %) > 0	–24.267
Economic potential: NPV(5 %) > 0	–0.019
Economically non-viable potential	–22.299
Market potential: Simple payback <= 3 years	–5.769
Market potential: Simple payback <= 6 years	–9.879
Total technical potential	**–62.233**

STEP 3. To each economic group of measures we attach a “penetration curve” based on the level of economic effectiveness. These are logistic curves, which are often used to model penetration of technologies to the market. We assumed that measures from group 1 could reach saturation level within 10 years, measures from groups 2 and 3 within 20 years, and remaining viable measures within 30 years.

The real potential of the CO_2 emission reduction measures in year 2010 is calculated using the above defined penetration curve. This real potential is a starting point for the assessment of the JI potential.

The estimated penetration of the measures until the year 2010 expressed as a share of technical potential according to individual class of measures is:

100 % measures with simple payback <= 3 years

65 % measures with simple payback <= 6 years

50 % measures with NPV(10 %) > 0

20 % measures with NPV(5 %) > 0

0 % economically non-viable measures.

The real potential of the mitigation measures is about 24 million tons (Mt) of CO_2/year in the year 2010.

Table 9. Real reduction potential of the measures in 2010

Economic class of the measure	*Reduction potential (Mt of CO_2/year)*
Economic potential: NPV(10 %) > 0	–12.133
Economic potential: NPV(5 %) > 0	–0.004
Economically non-viable potential	0
Market potential: Simple payback <= 3 years	–5.769
Market potential: Simple payback <= 6 years	–6.393
Total real potential in 2010	**–24.299**

4.2 GHG emission reduction potential of measures suitable for JI projects

STEP 4. The total real potential of measures for the year 2010 given in Table 9 is a starting point for the assessment of "JI potential." Economically "extreme" measures (projects)—unprofitable and highly profitable ones—are excluded from the list of measures suitable for the JI projects. Both are indeed unacceptable as JI projects. The first group of measures is unprofitable under any standard conditions and thus will not be attractive also for the JI. On the other hand, the second group of measures (projects) is very profitable (low-cost or "no-regret" measures) and should therefore be implemented using domestic sources in any case. In other words, these profitable measures are part of the BAU scenario. This categorization results from the experience with current investor's strategy in the Czech Republic in the area of the energy savings measures. The remaining emission reduction potential, or "real reduction potential" is presented in Table 10.

A survey carried out across manufacturing industries in the Czech Republic in 1993 among a representative sample of 43 industrial companies from all branches showed that the simple payback period was used in 80 percent of companies to make at least a preliminary evaluation of investment.[43] The average payback time for a "small investment project"[44] was slightly over half of the average payback period for "large investment projects": 3.5 years against 6.7 years. On average, the required payback period for small projects did not differ that much among industrial branches, but there was a clear difference of payback period for large projects across industrial sectors. This obviously reflects the difference in lifetime of the equipment needed by individual sectors. This type of measures is realized without any loan or external financial source.

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[43] Energy Conservation Stimulation Programme for the Czech Republic. Phase I: The manufacturing sector. ECN, Petten, 1994.

[44] This category includes many energy saving measures.

Table 10. Real reduction potential of the measures for JI project potential assessment (JI potential)

Economic class of the measure	*Reduction potential (Mt of CO_2/year)*
Economic potential: NPV(10 %) > 0	–12.133
Economic potential: NPV(5 %) > 0	–0.004
Economically non-viable potential	0
Market potential: Simple payback <= 3 years	0
Market potential: Simple payback <= 6 years	–6.393
Total JI potential	**–18.530**

STEP 5. The remaining measures are not profitable enough under current economic conditions. The real reduction potential of these measures for year 2010 is about 18.5 million tons (Mt) of CO_2 . We refer to this potential as JI potential because these projects pass the initial additionality test in the sense that they would not be implemented in the BAU scenario.

However, we have to exclude from this list the measures that could become mandatory in the short-term as a result of new legislation. As discussed in previous sections, measures required by law cannot be considered additional. The sector-by-sector list of all individual measures along with their applicability as JI projects is given in Annex 5. Measures that could fall into the baseline because of EU accession-related regulations are excluded from JI potential. The remainder (13.3 $MtCO_{2\ eq}$/yr) is the "*real JI potential*" (Table 11).

Real JI potential presented in Table 11 is distributed to individual sectors. The "tradable share" of the real JI potential is estimated as a sum of those projects having a GHG emission reduction potential greater than 1,000 tons of CO_2 per year. These measures cover about 18 percent of the above mentioned "real JI potential" or 2.4 $MtCO_{2\ eq}$ /yr.

Table 11. Real JI reduction potential of the measures suitable as JI projects and its tradable share

Sector	*Real JI potential (Mt of CO_2 /year)*	*Tradable share (%)*
Residential sector	7.54	0
Transport	0	–
Industry	2.61	57
Tertiary sector	0.51	0
Agriculture	0.09	0
Municipal energy sources	0.21	66
Renewables	2.31	33
Total real JI potential	**13.27**	**18 (2.4 $MtCO_{2eq}$)**

The reduction potential shown for individual sectors includes also the emission reduction, which is achieved by a decrease in electricity and district heat (DH) consumption in these sectors, but the real emissions are reduced in the electricity and DH production sector. This emission reduction is recalculated into the individual sector of the final consumption (households, tertiary, etc.) using the average emission coefficients of the electricity and DH production in the Czech Republic.

STEP 6. The total real potential of the measures suitable as JI projects until the year 2010 is about 13.3 million tons of $CO_{2\ eq}$. But "tradable" projects—that is, projects which reduce emissions by more than 1,000 $tCO_{2\ eq}$ annually—represent only 18 percent of this total, or about 2.4 million tons annually. The rest are micro-projects and various activities presenting 72 percent of the real JI potential.

This potential—measures not attractive enough to be part of the BAU scenario, and which are not likely to become mandatory in the short run because of EU accession and which would reduce emissions by more than 1,000 t $CO_{2\ eq}$ annually—covers a group of 345 projects in the general catalogue of measures (part of MARKAL model) used for the present study. These projects have been identified in industry (120 projects), in use of renewables (115 projects), and municipal heating sector (110 projects). The average size of the project in industry is 12.3 thousand tones, 6.7 thousand tonnes in case of renewables, and 1.2 thousand tons in the municipal heating sector. The total tradable JI potential is estimated as 2.4 million tons of $CO_{2\ eq}$, which is only 18 percent of the theoretical JI potential. In other words, most of the JI potential is made of projects with a reduction capacity of less than 1,000 tons per year.

Of course, dispersed activities and micro-projects could be grouped into programs. However, the current design of JI rules is not yet suitable for such programs. PCF and PCF*plus*, among others, are currently looking for ways of bundling small projects, for example in the energy efficiency field. This activity could increase the tradable part of JI potential mentioned above.

Although, the experience of financing and monitoring of such small projects by State Environmental Fund of the Czech Republic (SFZP CR) is good, recent proposals to combine JI investment with national environmental funds does not seem to attract much interest by investor countries.[45]

The evaluation process of prospective JI projects identified above does not depend on the price of ERUs. We expect that the economically non-viable projects will not come into the JI project portfolio during the first commitment period. In our calculations, we do not consider a possibility that some JI projects are implemented in the sectors affected by the EU regulations, simply by buying ERs before the date at which the EU rules come into the force. We expect that the clear and obligatory rules for JI projects will be established for the whole first commitment period, which will also reflect the currently prepared EU legislation.

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[45] L. Nondek, "National Strategic Studies on JI in the Czech Republic, Russian Federation and Slovak Republic." In Contributions fron NSS Program to COP-6 Negotiations regarding CDM and JI (T. Black-Arbelaez Editor), NSS Program, World Bank Washington, September 2000.

5. Implementation costs

The implementation costs of programs like JI or national Emission Trading typically involve costs of institutional building, planning, project design, project assessment, monitoring, transaction costs related to trading, information dissemination, human resources training, and so forth.[46] They can be categorized as follows:

- Project design related costs, which cover preparation of individual project proposal and baseline calculation
- Administration costs are costs of project proposal assessment by the competent authority
- Transaction costs cover all activities related to credit generation (monitoring, reporting, report assessment, and verification and certification)
- Barrier removal costs are costs of all activities related to institutional strengthening, establishing legal framework, administrative procedures, human resources training, and so forth. They are usually aimed to short- and medium-term reduction of transaction costs.

In the categorization scheme of PCF, the project design and transaction costs of the whole project cycle are broken roughly into:

- Baseline development
- Monitoring and validation protocol
- Project concept document + project assessment document (including environmental, social and financial due diligence)
- Carbon asset due diligence
- Validation
- Project document
- Consultations and negotiations
- Legal documents, including purchase agreement.

This whole project cycle, where the above costs can amount 300 thousand USD, is designed for large investment projects over 3 million USD of carbon finance. These costs depend less on the project size (e.g., installed technical capacity or forest area) than on its complexity (including baseline development). Those costs are covered fully by PCF. There is also a possibility of project bundling, which would reduce the above costs.

[46] K. Halsnaes, J.M. Callaway and H.J. Meyer, „Economics of Greenhouse Gas Limitations, Methodological Guidelines" , Ch. Implementation Costs, UNEP and RISO National Laboratory, Roskilde 1998.

A certain part of transaction costs has to be covered by the host country. They are two approaches to discuss implementation costs at this level. The first approach is usually based upon experience from AIJ, which may sometimes be misleading. This experience shows that there is a lack of a considerable institutional capacity in terms of, *inter alia*:

- Legal framework in order to deal with investment property rights
- Clear criteria for considering a project proposed AIJ/JI (definition of BAU, additionality, etc.). Sometimes it took over a year to obtain a letter-of-approval from the government of the host country;
- Assistance for calculation of the baseline scenario for AIJ/JI projects; next to the general conceptual complications related to baselines, it is often problematic to find the statistical data and background information sufficiently credible to calculate a baseline.

Above factors hampered the implementation of AIJ projects in Central and Eastern Europe. In order to support the development of JI projects by the potential host countries, the following topics need to be addressed in more detail:

- Build-up institutional capacity to enable host countries interested in JI to successfully co-operate with investors like PCF.
- Provide incentives for EU candidate host countries to identify and carry out JI activities in synergy with implementing the legislation adopted during the EU accession.
- Address specific Kyoto Protocol (KP) Article 6 issues recently addressed at UN negotiation sessions, such as the required project cycle for JI projects (especially in comparison with the project cycle for CDM), and the role of private sector entities in establishing projects and transferring ERUs from one Party to another.

It is obvious that without carefully prepared institutional support of JI activities on the side of the host country, the JI projects will be treated on ad hoc basis like the AIJ ones, and incur high transaction costs.

A general rule is observed in the Czech Republic that authorities are reluctant to make ad hoc decisions, which are not guided by national legislation and/or prescribed in detail, by ministerial guidelines. There are deadlines for response of competent authority laid down in acts and decrees as well as contents of applications, technical standards, ELVs, etc. This means that a political decision on a sufficiently high level must be made first to prepare such legal and procedural framework, with a competent authority identified, and with legislation or binding guidelines prepared and adopted before any standard procedure starts.

As in the case of transposition and implementation of the EU legislation, general obligations are transposed into existing administrative and the legislative framework. If there is political will and interest, the legal framework and procedures can be established quite rapidly. Up to now, no such interest has been expressed by domestic interest groups like business, industry, and municipalities because of low economic incentives (expected price of ERU) presented by JI and the complicated nature of “additionality” requirements. As the domestic stakeholders are excluded from JI investment trading of ERs, no strong domestic group of stakeholders politically supports JI at MoE or Parliament.

5.1 Costs of removing administration and administrative barriers

The transaction costs should be shared between operator (investor) and the host country government. To cope successfully with a large number of running JI projects, the host country government must establish an agency approving projects, maintaining the project registry, receiving project reports, and submitting certified credits to the UNFCCC trade register. Preparation of JI baseline manuals, GBRs for IPPC projects, and so forth could be contracted to external experts. The designated agency should also inspect or audit randomly selected installations (elimination of baseline cheating). To estimate the size and budget of such agency, one can use environmental impact assessment (EIA) procedure or currently designed IPPC procedure as a benchmark for likely administration costs of JI projects.[47]

Role of investor (operator) is to prepare all necessary documentation and reports and submit them to the competent authority. The authority issues the operational or construction permit or returns the application with a negative standpoint. The authority may use an external legal or technical expert. Written guidelines are often issued to help applicants.

Investor should cover costs of self-monitoring, reporting, verification of reports, and certification of credits with respect to the individual JI project. Self-monitoring must be based upon verifiable records like purchase and consumption of fuels, power, invoices and other accounting documentation. Monitoring procedures should be proposed as a part of project proposal (application) by operator and approved by the competent authority as it is expected in case of an IPPC permit.

The following estimate is carried out for 345 prospective measures (projects) selected in the previous section, yielding a total reduction potential of 2.4 Mt CO_2. We estimate that 10 man-days should be necessary for the initial assessment of each project proposal and 3 man-days per year for project activities related to credits. Taking into account a 5-year validity of JI baseline, 345 JI projects would need 690 man-days for assessment and 1,035 man-days for crediting, which should be covered by 9 administrators and 3 technicians, including a secretary. We therefore estimate that a Czech JI Agency could have 12 permanent employees and a small budget to contract external technical experts.[48] Cost estimates are broken down in Table 12. Starting out the costs per project would be higher because of the initial costs of training, building databases, maintaining an information web server (help desk) for investors, etc.

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[47] DHV CR prepared several studies for MoE related to IPPC regulation including simulated permitting procedure.

[48] See Annex for detailled calculations.

Table 12. Cost estimates for the government agency

Item	*Total (in thousand USD)/year*
Personal costs (incl. taxes, health insurance etc.)	153.5
Office space, rent	15.8
Operational	17.7
Total	**187.0**

It is assumed that the 345 projects generate a JI tradable potential of approx. 2.4 mil tons/year of CO_{2eq} transferred hypothetically at an average prices of 2, 5, and 10 USD/tonne. The estimated host country revenues and the share of host country transaction costs (as percent of the revenues) are given in Table 13.

Table 13. Transaction costs for 345 JI projects (selected previously)

Price (USD per ton of CO_{2eq})	*Transaction costs (%)*	*Total revenue of host country (million USD)*
2	3.9	4.6
5	1.6	11.8
10	0.8	23.8
20	0.4	47.8

The transaction and administrative procedures must be therefore kept simple, standardized, and covered by trained domestic manpower (incl. experts hired by the agency), which must be in place before the JI credit transfer is launched. The above calculations are carried out for an average price of 2–20 USD/tonne of CO_{2eq}. If a large amount of cheap CDM credits is generated, the overall profitability of JI investment in the Czech Republic may become questionable, especially in the case of relatively small projects.

The above estimates are carried out for a hypothetical group of 345 JI projects (2.4 Mt CO_2 annually). However, the relative transaction costs (per ERU), which may depend upon the project complexity, will decrease with the increasing size of the project (effect of scale). Given the overall financial benefit from the JI credits, the national rules and administrative procedures must be relatively simple to keep transaction costs at a reasonable level. One may conclude, that a low price per ERU with simultaneously complex administrative procedures proposed by certain UN FCCC Parties will make JI rather unattractive for relatively advanced transition economies with enough direct investments like the Czech Republic, Hungary, Poland or Slovakia.

6. JI related investment risks

This section examines JI opportunities and risks from the point of view of foreign investors (domestic investors are excluded from JI). One can distinguish between three types of investors interested in JI projects:

- Direct investors focused on increasing the net present value (NPV) of their investment. NPV is defined as present value of the stream of net cash flows from the project minus the project net investment. If the project generates creditable emission reductions under JI, then the resulting ERUs will increase the stream of net cash flow, and thus make the project more attractive (increase of NPV).

- Investors interested only in acquiring ERUs, either to meet their obligation under another domestic regime or as a speculative financial investment. Investors interested in buying ERUs may choose various contractual arrangements with the project sponsor, among which future contracts and options may be very common.[49]
- Governments of the countries which expect to be unable to meet the national emission target adopted via the Kyoto Protocol. These governments are trying to find suitable investment projects via bilateral agreements with prospective host countries and invest their public funds in return for JI tradable credits. Those credits are expected to release economic or regulatory pressures on their domestic GHGs emitters.

The second and third type of investor has shown strong interest in JI in the Czech Republic. This also means that foreign or multinational companies which have invested in the Czech Republic in their core business (type 1 investors) may not be fully aware of potential revenues from JI credits. The following text is focused on risks related to the interests of the second and last category of investors, which are more exposed to specific type of risks (JI-related risks).

6.1 Project performance risk

All investors are trying to minimize the risks related to JI investment. The first type of the risk is project specific, which means that a JI project will not perform up to expectations. This risk is measured as a standard deviation of NPV of the JI project. In practice it means that JI credits are just one component of the cash flow and their sustainable generation depends upon overall performance of the project.

The performance of JI projects will depend upon energy prices (opening of energy market), prices of raw materials (recycling), use of economic instruments (waste management, renewables) or government subsidies (reforestation). Project performance is generally influenced by an environmental regulation like IPPC.

In a recent study,[50] the authors stressed that this type of investment risk can be reduced *via* a portfolio of JI projects. If the projects are well chosen, overall risk is decreased by diversification. In this case, the risk represents the variability of possible return from JI credits influenced by overall project portfolio performance. The project portfolios managed

[49] Future contract is a standardized contract traded on an organized exchange, which enables one to buy or sell a fixed quantity of a defined commodity (emission reduction units) at a set price in future. Futures create legal obligations to execute the contract at the agreed upon price at a given time. In contrast to futures, an option gives the buyer (or seller) the right, not the obligation, to buy (or sell) the underlying commodity.

[50] DHV CR, SRCI and Carl/Bro, "Estimate of the economic costs for Reduction of Greenhouse Gas Emissions," Phare Project No.CZ9705-05-01-02, Prague 2000.

by private or government agencies like the State Environmental Fund (SFZP CR), Czech Energy Agency (CEA), Agriculture and Forest Fund (Podpurny a garancni rolnicky a lesnicky fond, a.s.), etc., could receive and redistribute investment funds based on forward contracts with investors.

Some investors (mainly investor country governments) are trying to separate project-related risks from the generation of JI credits—and therefore asking host country governments to bear them completely—by asking for a transfer of JI credits regardless of the real performance of the project. But any project must be profitable (NPV>0) to be operated in a sustainable way and no projects should be being implemented simply on the basis of JI credits. Should an installation close permanently, no transfer of ERUs should take place. This way of separating the primary (production) function of an investment project from collateral revenues of JI credit generation, which is usually incomparable with NPV, would in our view only yield perverse results.

6.2 Risks related to baseline and additionality

In accordance with our above description of the changing regulatory framework, there is an obvious baseline risk associated with changes in the definition of the BAU scenario. In the case of EU candidate countries, some evolutions in the BAU scenario are predictable. For example, there is a plan detailing future legislative activities of the government. In addition, there are implementation plans both at European Commission and national level for certain sectors, such as energy efficiency, air protection, or waste management. These plans are usually good indicators of future legislative changes. Last, we see predictable changes of EU legislation in progress, which will at a later stage be transposed into national legislation.

On the other hand, investors are averse to parameters varying unpredictably, especially if they lead to dynamic baseline fluctuations. As a result, an important task of the above JI national agency should be to prepare sector scenarios valid for a certain period of time, e.g., 5–10 years. In such a case, project baselines should be related to sector scenarios officially published, containing all basic parameters such as energy efficiencies, emission factors, macroeconomic projections, and so forth. Plausible BAU sector scenarios prepared officially should include the most plausible technologies, which must meet BAT criteria in case of IPPC-regulated activities. As noted above, GBR could be used in this context as a binding set of parameters related to parameters influencing only GHG emissions (there are no local effects) of IPPC installations.

Such an approach should help investors at a very early stage of their decision process. In case of bundling small projects, the rules for baseline calculations should be relatively simple. Having well-developed sector or technology specific BAU scenarios would be very helpful for both sides. It reduces the time to prepare a project proposal by investor, examine it at the agency level, and it certainly eliminates time consuming discussions between the agency (representing also other regulators) and the investor. Information availability and transparent decisionmaking related to all critical factors influencing project baseline (and thus possible impacts on project performance) should eliminate this risk completely.

This type of risk could be covered partially (e.g., up to 20 percent of annual ERs generated in previous year) by an option or a forward contract between the investor and the agency (host country government), which would sell deficient ERUs at a fixed price. Another reason for decreased generation of ERUs could be more stringent overall environmental regulation, which is however a standard investment risk not specifically related to the JI function of the project. We think this risk must be fully covered by the investor.

6.3 Risk related to development of Kyoto flexible mechanisms

Another risk is trading mechanisms that compete with JI. The Kyoto Protocol establishes that countries with emission targets (Annex I Parties) can trade parts of their assigned amounts or emission reduction units from projects with other Annex I Parties, and buy certified emission reductions that are generated from projects in developing countries (non-Annex I Parties). Trade can take place in various ways under the following mechanisms:

- Joint implementation (JI). Article 6 of the Kyoto Protocol establishes that entities within Annex I Parties can buy emission reduction units from projects reducing emissions in another Annex I country.
- Clean development mechanism (CDM). Article 12 establishes that Annex I Parties and entities in Annex I countries can buy emission reductions from projects in developing countries.
- Emissions trading (ET). Under Article 17 of the Kyoto Protocol Annex I Parties (or entities within these countries) can trade parts of their assigned amount.

Each mechanism has a different function, rationale, and governance mechanism. The CDM, for example, also supports sustainable development in non-Annex I countries, and has more elaborate governance provisions. However, the Marrakesh Accords have confirmed that the emission reduction units stemming these three mechanisms will be interchangeable. This means that all three mechanisms should be combined together in a single international trading system.

Some candidate countries, including the Czech Republic, are planning to implement domestic emissions trading (ET) systems before the beginning of the first commitment period. This will enable them to gain experience with ET, to reduce their emissions cost-effectively, and to facilitate the future participation of their entities in an international ET system. Rules for the international trading system (to be established in the UNFCCC negotiations and expected steps of the EU in this area) may influence the future structure of domestic trading systems.

In our view, the most likely scenario (particularly in view of the Bonn Agreement and the Marrakesh Accords) is that the Protocol should enter into force in 2002. EU members and accession countries may move ahead to implement policies and measures under the expectation that the Kyoto Protocol will enter into force, which will provide certainty over the amount of emission reductions required over the next decade.

Another concern for JI in the future is that the rules governing the CDM are now well elaborated and have been approved by COP-7. Similar provisions, rules, and modalities for JI are not so well prepared. Standards and procedures for the accreditation of independent entities, reporting guidelines and criteria for baselines, monitoring and crediting periods are still missing. This is the reason why the Czech MoE has a serious concern that JI projects would not be economically competitive with CDM projects during the first commitment period. It is particularly important because most of the JI projects in the EU accession countries will be oriented toward energy, industry, and residential sectors, where emission reductions are more expensive.

6.4 Risk of non-compliance with Kyoto protocol

The transfer of ERUs can be only made if the JI host country complies with its Kyoto target. The concerns for JI and ET are associated with compliance assessment, which is based upon a comparison of actual GHG emissions inventory with the national emissions target. Transfers of emission permits will affect the tonnes of CO_2 equivalent that an individual Party to the Protocol can legally emit (national emission ceiling).

The process should ensure that each Party's inventory is of high quality in order to ensure that compliance process is not jeopardized by unforeseen inventory adjustments. A practical step to facilitate JI by industry in accession countries is to agree on a credible system for monitoring emissions from entities that participate in JI.

6.5 Roles of investors and government

To sum up, besides known risks like poor project performance, risks related to sectors or geographic regions or fluctuations of asset value, which can be managed by standard techniques, the following risks specific to JI have been identified:

- Risk related to JI baseline and additionality, which depends upon development of JI approval mechanisms. As follows from the previous discussion, baseline changes might occur because of changed legal requirements or definition of BAT for individual cases.
- Risk related to development of Kyoto mechanisms, competition of ET and CDM
- Non-compliance risk related to the host country compliance with the Kyoto Protocol.

Investors are not able to manage this part of the JI specific risk, because those risks are political. As a result, the host country government must assist JI investors in setting warranties, rules, limits, and guidelines.

On the other hand, non-political risks have to be managed by investors. They can be hedged by use of such instruments like options or futures. In the absence of such tradable assets, future contracts (non-tradable) can be used. Government must however agree with such contracts but should not accept provisions forcing full transfers of ERUs, even in case of complete failure of the project.

Examples of various risks are presented in Table 14.

Table 14. Summary of JI projects related risks and recommended measures

Type of risk	*Risk management (investor)*	*Assistance of host country government*
Kyoto Protocol failure/delay	Wait or engage in AIJ project with prospective to be converted to JI	Ratification, active participation in negotiations; warrant AIJ to be converted to JI (issue conversion rules)
“Additionality” risk (project not approved internationally)	Restrict investment to sectors with clear “additionality”	Define sectors suitable for JI, define sectoral BAU
Overall poor performance of the project (low or negative NPV)	Sound investment decision, diversification (project portfolio at company level), option or forward trades the with Agency	Keep low transaction costs via transparent administrative procedures, offer low-interest loans from SFZP CR, reduce taxes for JI projects
Natural disaster, forest fire, industrial accident	Insurance as obvious	Include accident insurance as an obligation into JI general rules
Baseline changes, IPPC	Require uniform timeframe, guidelines or GBRs to make this issue transparent etc.	Issue guidelines, GBRs etc.
Fluctuation of asset (JI credit) value	Options and forward contracts	Permit this kind of transactions, create legal framework
Non-compliance of the host country (economic growth, Temelín NPP)	Require Government warranty (compensation)	Set the limit on tradable volume (safety margin) based on reliable inventories and projections, offer full compensation (warranty) in the case of KP non-compliance
Sector or region related risk	Proper choice of sector/region, diversification	None in respect to individual projects (investor bears the risk), support portfolio investment funds (e.g., PCF)

6.6 Further development of JI in the Czech Republic

The MoE, which is responsible for the UNFCCC activities, has developed further version of rules previously formulated for AIJ (1997). It is expected that these rules will be published as an Annex to the Third National Communication to the Parties to the UNFCCC. A JI unit is being established at the MoE under a close cooperation with the Climate change unit of the Czech Hydrometeorological Institute (responsible for annual inventories, drafts of policies and measures, coordination of drafting the National Communications, etc.).

As a result of preliminary internal discussions, it has been proposed that a total amount of emission credits of up to 4 million tons of $CO_{2\ eq}$ should be reserved for JI projects in coming years. Municipal and residential sector energy savings, use of renewables and forest management are viewed as suitable sectors for JI projects.

We expect negotiations on whether several AIJ projects implemented in recent years could eventually be converted into standard JI projects to take place. It is also expected that part of AIJ investors will be encouraged to submit reviewed JI baselines taking into account more specific scenarios including the EU accession related measures and recent development of the national legislation.

No real obstacles to achieve the Kyoto Protocol reduction targets are seen but the progress likely will be affected by medium-term energy consumption patterns and economic growth. However, energy production from the controversial Temelín Nuclear Power Plant (NPP) has a prominent effect on the country's GHG reduction potential. The closure of Temelín NPP, which has been demanded by Austria and domestic environmental NGOs concerned about the safety of the NPP, would negatively affect the possibility of meeting the Kyoto targets.[51]

In January 2001 the Czech MoE initiated a case study on establishing a domestic emissions trading program with European Union countries. The program is to be launched immediately upon the Czech Republic entry into the EU, expected not earlier than 2004.

7. Conclusions

1. EU accession, which requires transposition of large volume of the EU legislation into national law, makes it more difficult for proposed JI projects to pass the "additionality" test, as some measures become mandatory under the new legislation.
2. Our study, based on the MARKAL database of emission reduction projects, shows that the real JI potential in the Czech Republic—that is, projects not attractive enough to be part of the BAU scenario and not likely to become mandatory under legislation implemented because of EU accession—represent about 13.3 million tons of CO2eq.
3. Of this JI potential, the estimated tradable JI potential—that is, projects generating more than 1000 tCO2eq of emission reduction annually—is about 2.4 million tons of CO2eq, namely, only 18 percent of real JI potential.
4. This tradable potential is spread over a group of 345 "fully additional" hypothetical projects (industry, renewables, municipal heating sector). Transaction costs covered by the host country and estimated for the above group of projects are based upon analogy (benchmarking), with similar existing administrative procedures, such as EIA. At a price of 5 USD/ton of CO2eq the implementation costs to be covered by the host country government represent 1.6 percent of the total volume of emission reductions generated.
5. At a cost of 5–10 USD/ton of CO2 eq , the overall stream of JI-specific revenues generated by the above group of 345 hypothetical projects is approximately 12 millions of USD/year, which is less than 1 percent of current total foreign direct investment in the Czech Republic. Under these circumstances, JI does not represent a

[51] The Temelín NPP went on line in October 2000 and has not yet passed through all the required tests. If the Temelín NPP is not put into operation, the emissions of the Czech Republic will be about 8 percent higher and the loss of Temelín's expected electrical production may require compensation by fossil-fuel fired power plants.

strong economic incentive. It could in particular not cover much of EU pre-accession costs, which are expected to be 10–15 billions of USD. At present there is no synergy between the EU pre-accession process and JI, which puts JI at a lower priority level.

6. Small projects and micro-projects represent the major part of the JI potential. Tapping this potential thus requires a tailor-made use of economic instruments combined with specific programs (such as energy savings in residential sector, reforestation, use of renewables). The activities suitable for JI should be supported and financed by existing institutions such as the State Environmental Fund, Energy Agency, and Forest Fund. Forest certification of whole regions is an example of such an approach covering hundreds or thousands of small forest owners.

7. Underestimation of specific problems from the side of investor countries or large institutional investors only leads to unnecessary misunderstandings. Design of fungible and effective mechanisms using Kyoto Protocol potential needs a bit more flexibility, which would take into account the specific situation of the EU candidate countries. Government-to-government or Government-to-international financial institution trading, which would yield revenues used for support of the tailor-made programs, but not launching ad hoc chosen individual projects, seems to be the best choice along with developing a national emission trading system incorporating also JI and combined with a use of economic instruments (e.g., tax reform) to ensure country compliance with its Kyoto target.

8. There are normal investment risks related to project performance and JI specific risks related to additionality (baseline setting), development of Kyoto flexible mechanisms and country non-compliance. Investors are not able to manage these JI specific risks, because those risks are political. In this case, the host country government must assist JI investors in setting warranties, rules, limits, and guidelines. On the other hand, non-political risks (poor project performance, accident, volatility of energy prices etc.) have to be managed by investors.

9. If JI is chosen as the preferred option, the Czech Government must reduce the JI-related political risks setting clearly, which project categories are "fully additional." Simple and effective administrative procedures are a prerequisite to keep domestic transaction costs well below 5 percent of the JI generated revenues. Growing demands on administrative procedures focused on individual projects (assessment, monitoring, reporting, verification, certification) will require establishing a specialized agency. Transparent guidelines for investors, well-prepared administrators, and web-based reporting and information systems are the tools to decrease the overall implementation costs and JI investor's risk.

10. The situation of other EU candidates may resemble the Czech situation described here. Before making any strategic decision related to JI or ET, governments of the EU-candidate countries should estimate tradable JI potential constrained by their new EU-related legal obligations as well as by project size.

Annexes

1 The MARKAL model for the Czech Republic

1.1 Introduction

The MARKAL model is a linear optimization model. The center of its use lies in the optimization of the structure of the energy resource part of the national or regional energy system in terms of minimization of necessary costs to cover given energy demands, while respecting other conditions and constraints introduced by the solution provider (reduction of the emissions of selected types of pollutants, reduction of total investment costs, etc.).

Due to the fact that work is continuously being performed on the perfection of both the mathematical formulation of the model and its application to the conditions of various countries (update of technology databases, more detailed structuring of the energy production and consumption sectors), the model makes it possible to also solve other specific tasks. It is, for instance, possible to analyze:

- The effect of price changes on the volume and demand for individual types of energy carriers;
- The effect of reduction/increase in production, mining (extraction) or import of one type of energy carrier on the production of another type of energy carrier;
- The effect of setting emission constraints (at national or individual source level) for selected pollutants on the structure and volume of primary energy sources and demand for energy;
- The effect of the introduction of taxes on selected types of energy carriers/pollutants;
- Costs of reducing the emission of selected types of pollutants; and
- Evaluation of technology in terms of cost efficiency, etc.

For data input and analysis of the results of optimization and all other work with the model, a user program (user interface) must be developed - MUSS (MARKAL User's Support System), which makes work with the model and analysis of the results easier and user friendly.

The model is a so-called 'bottom-up' model, which describes energy sectors by specification of energy conversion technologies and energy service demands. MARKAL determines a least-cost mix of energy conversion technologies to meet energy demand over the period considered which is exogenous set by the model user. Therefore the model is a convenient tool to analyze the future role of energy technologies within a national context. Consequently, it supports energy policy making processes.

MARKAL is one representative of the class of least-cost optimization models. Others ones are for instance EFOM/ENV and MESSAGE. They share many common features, such as an integrated assessment of a national energy system, including environmental consequences. They vary in the user system supporting the model and the level of detail. Key objectives have been mostly:

1. Penetration of new technologies;
2. Impact of fuel price changes; and
3. Impact of emission reduction strategies on the energy system.

The development of national energy strategies requires elaborated and common accepted tools. Medium and longer-term energy strategies are often supported by energy model calculations based on minimization of the total discounted costs of considered energy sectors. Minimization of the *total energy system costs* favors an integrated analysis of the whole energy system by taking into account cross-links between energy sectors. Furthermore, minimization of the *discounted cost* results in a dynamic behavior of the energy model over the time period considered, simulating perfect foresight for the energy system. Uncertain future developments are dealt with by making use of several scenarios providing a consistent framework for setting exogenous model variables. Synthesis of scenario results provide insight in for instance the robustness of alternative energy policy instruments affecting the future role of energy conversion technologies for reaching energy or environmental policy targets.

1.2 General model description

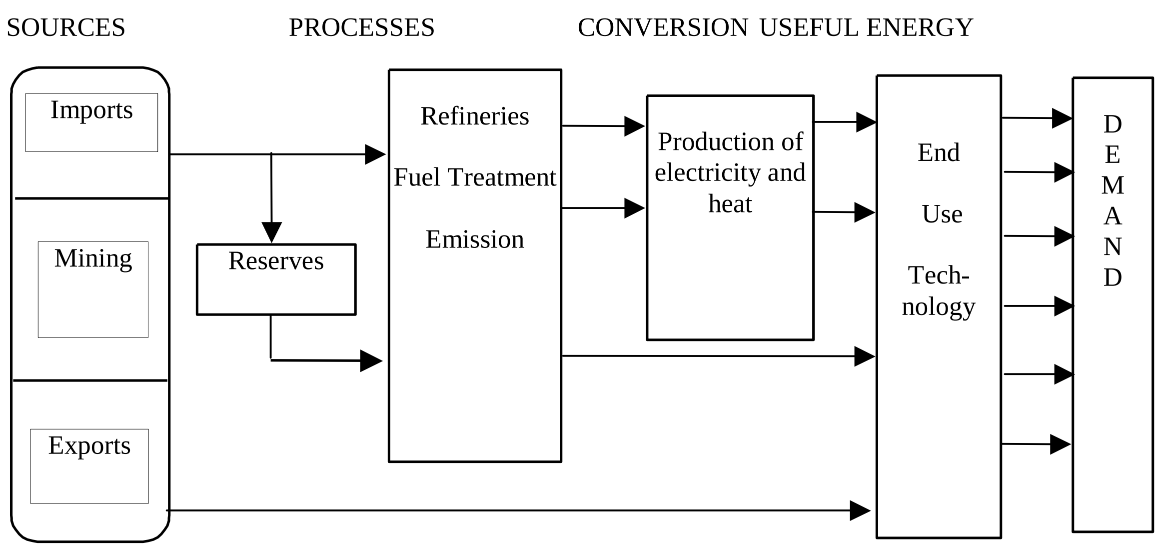
The MARKAL (MARKET ALLOCATION) model is a demand driven, multi-time period liner program model of a generalized energy system using the linear optimization method.

The MARKAL model was developed within the scope of the ETSAP (Energy Technology Systems Analysis Program), under the auspices of the International Energy Agency (IEA/OECD). The model is used in a wide range of applications by the ETSAP[1] members to study their national and regional energy systems as well as by IEA to prepare a global energy strategy.

MARKAL is a linear optimization model of an energy system with freely definable time periods for modeling over a maximum time period of up to 45 years in 9 time periods, each with a duration of five years (the maximum number of time periods is 9 with a duration of between 1 to 5 years, i.e. 9x1, 9x2, 5x5 etc.). Its essence is the so-called technology model of the energy system, driven by demand for useful energy (or final consumption), which is presented as an exogenous variable. This is a dynamic model, which can be configured in such a way as to represent any geographical area or region. In most of the MARKAL applications, the model was configured for a national energy system, but its application in the modeling of energy systems for smaller regions is gaining ground, for which the requirements of local energy planning are also important.

The classical structure of the model is shown in Figure 1.

Figure 1: Basic structure of energy system model



The heart of the model is a database composed of technical and economic data which describes individual energy technologies (electric power plants, combine heat and power plants, heating only plants, refineries, etc.), together with data on primary fuels and their prices and also energy demand data.

The input and control variable is demand (for useful energy or individual types of energy carriers) and the output from the model is an optimum cost balance of energy resources in the individual time periods, which in full measure satisfy the projected demand.

Primary energy sources are obtained by various technologies (extraction, mining, etc) or from import, further transformed by refining and conversion technologies into various types of energy carriers, such as fuels, electricity and heat. These energy carriers are further used in consumer end use technology to satisfy demand for useful energy in the individual end use sectors. Demand for useful energy is expressed in the model directly as demand for various types of products and services, such as - pig iron, steel, passenger-kilometers in railway transport, ton-kilometers in

[1] Current members of ETSAP are: USA, UK, Japan, Belgium, Canada, Germany, Switzerland, Norway, Sweden, the Netherlands, Italy and the EU.

road goods transport, hot tap water in households, etc. Demand for useful energy can be disaggregated into various sectors and sub-sectors in accordance with user requirements and availability of data, especially cost data.

MARKAL is a technical-economic model, which database is composed of mainly technical data, describing energy inputs and outputs for a large set of technologies, their efficiency, costs (investment and operational - fixed and variable), their lifetime and availability. The prices of primary fuels (respectively, acquisition costs - mining, transport ...), specified as exogenous inputs into the model, are also contained in the database.

As an objective function for optimization the model uses minimization of discounted costs for the whole energy system for the whole model time period. During the optimization process it is required that the model ensures the satisfaction of all exogenous demand for useful energy, as well as respects all other constraints, for instance all limits to the availability of primary resources or emission limits, specified in the model. For the fulfillment of these requirements the model installs sufficient technological capacity at minimum cost in order to make it possible for the system to meet all demand at the desired level. The model uses a common discount rate for all technologies and for the whole model time period.

For model construction the following data is necessary:

- List of energy carriers represented in the model;
- List of technologies and their characteristics;
- Available volume of domestic energy sources;
- Import and export prices of energy carriers and their future development;
- Demand for useful energy by each end use sector; and
- Other exogenous constraints such as emission limits, emission coefficients, import limits and capacity constraints, etc.

For characterization of technology the model requires the following technical data:

- Input energy carriers;
- Output energy carriers;
- Technology efficiency;
- Capacity of technology and its use;
- Lifetime of technology;
- Investment cost per unit of installed capacity;
- Fixed operating and maintenance cost per unit of installed capacity;
- Variable operating and maintenance cost per unit of output (excluding fuel costs); and
- Emission coefficients.

The variables presented in the model are either exogenous or endogenous ones. Exogenous variables are, for example - demand for useful energy, import prices, technology costs, etc. Endogenous variables in the MARKAL model comprise the following categories:

- Variables which represent the individual energy carriers;
- Volume of each form of energy (fuel) available in each time period;
- Variables which characterize individual source technologies;
- New investments into each technology in the individual time periods;
- Installed capacity for individual technology in the individual time periods;
- Useful technology capacity in the individual time periods; and
- Variables characterizing the individual final consumption technologies.

The values of these variables are determined by solving linear optimization.

The model comprises a series of logical relationships (requirements), which are closely related to the variables. These requirements are mainly:

- Meeting energy demand,
- Balance of energy carriers,
- Production limits,
- Production capacity savings,
- Exogenous market penetration constraints for each of the individual energy carriers,
- Further requirements such as maximum permissible emission from energy systems, etc.

For each time period the model generates the following kinds of outputs:

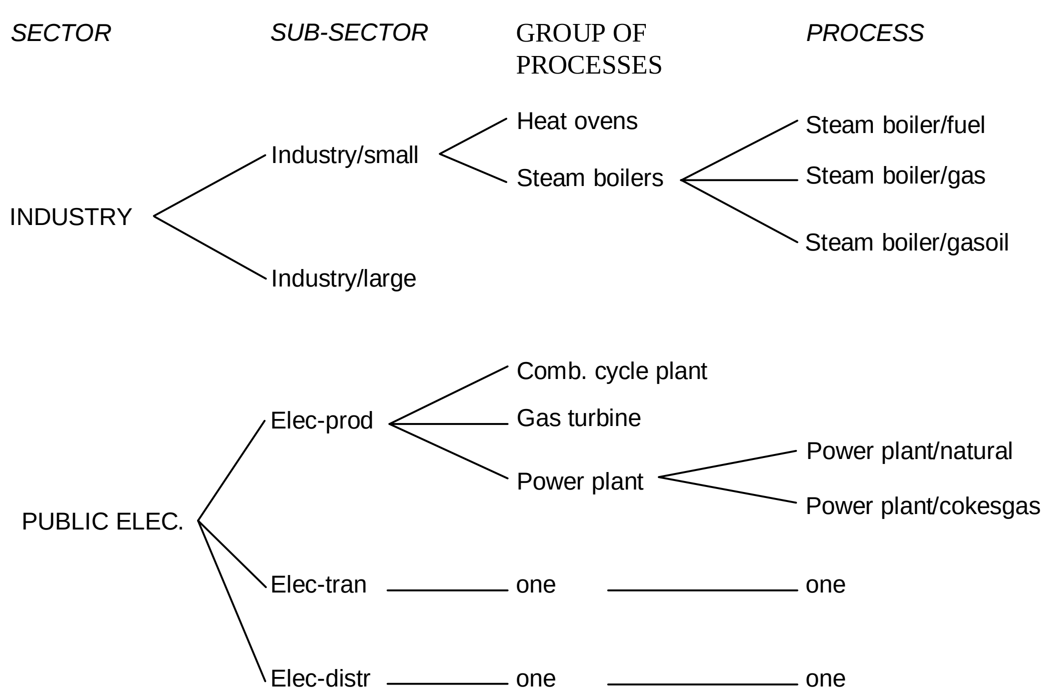
- Increase/reduction in the capacity of the individual energy technologies;
- Production level for individual technologies;
- Fuel and energy consumption in individual end use technologies;
- Outputs of useful energy from end use technologies;
- Identification of the most cost effective technologies;
- Volume of all used types of fuel and energy;
- Marginal prices of individual fuels and energy;
- Reduction costs for individual activities;
- Emission volumes;
- Energy system costs; and
- Sum evaluation of energy system for complete optimization period.

1.3 General design of the Czech MARKAL model

MARKAL is a process (technology) oriented description of the national energy system. The energy processes are connected to each other by energy flows, thus creating a network. Consequently the nodes in this network represent the energy conversion processes and the links between the nodes are the intermediate energy deliveries between the processes.

The energy system is divided into several supply and demand sectors. Supply sectors cover the production of final energy carriers in the energy system from imported or extracted primary energy carriers. In the demand sectors these final energy carriers are converted in useful energy demand. Distinction between different sectors allows defining energy balances, cost and emission tables for each of these sectors. The number and type of modeled supply and demand sectors is not restricted and depends on the required output.

Figure 2: Example of the possible hierarchical structure of processes (technologies)



In the Czech model four supply sectors and five demand sectors are defined, which are listed in the

Table 1.

Table 1: Supply and demand sectors

SUPPLY	*DEMAND*
Gas-sector	Agriculture sector
Coal-sector	Industrial sector
Oil-sector	Residential sector
Public Electricity	Tertiary sector
Urban Cogeneration	Transport sector
Industrial Cogeneration	

For each sector, the specific technologies are defined based on the real situation in the Czech energy sector and the possibilities of its future developments. The processes (technologies) are the basic levels of the modeled energy system. For each technology in the MARKAL model, there is need to provide detailed cost, performance, availability and emissions data structured as follows:

- List of input energy carriers;
- List of output energy carriers;
- Energy efficiency;
- Availability of technology in the individual time periods (for instance, date of the first availability on the market);
- Lifetime of technology (technical lifetime);
- Investment cost per unit of installed capacity;
- Fixed operating and maintenance costs per unit of capacity;
- Variable operating and maintenance costs (excluding fuel costs) per unit of output (production); and
- Technology specific emission coefficients.

The selection and definition of the level of technology disaggregation in the model is to a great extent determined by the availability of data and the performance of the computer used for modeling.

2 EU legislation related to JI

2.1 COUNCIL DIRECTIVE 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control

Article 2: Definitions
For the purposes of this Directive:
'installation' shall mean a stationary technical unit where one or more activities listed in Annex I are carried out, and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution;
'best available techniques' shall mean the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole:
- 'techniques' shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned,
- 'available' techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator,
- 'best' shall mean most effective in achieving a high general level of protection of the environment as a whole.

In determining the best available techniques, a consideration should be given to the items listed in Annex IV;

Article 3: General principles governing the basic obligations of the operator
Member States shall take the necessary measures to provide that the competent authorities ensure that installations are operated in such a way that:
(a) all the appropriate preventive measures are taken against pollution, in particular through application of the best available techniques;
(b) no significant pollution is caused;
(c) waste production is avoided in accordance with Council Directive 75/442/EEC;
(d) energy is used efficiently;

Article 4: Permits for new installations
Member States shall take the necessary measures to ensure that no new installation is operated without a permit issued in accordance with this Directive,

Article 6: Applications for permits
Member States shall take the necessary measures to ensure that an application to the competent authority for a permit includes a description of:
- the installation and its activities,
- the raw and auxiliary materials, other substances and the energy used in or generated by the installation,
- the sources of emissions from the installation,
- the conditions of the site of the installation,
- the nature and quantities of foreseeable emissions from the installation into each medium as well as identification of significant effects of the emissions on the environment,
- the proposed technology and other techniques for preventing or, where this not possible, reducing emissions from the installation,
- measures planned to monitor emissions into the environment.

Article 8: Decisions
Without prejudice to other requirements laid down in national or Community legislation, the competent authority shall grant a permit containing conditions guaranteeing that the installation complies with the requirements of this

Directive or, if it does not, shall refuse to grant the permit. All permits granted and modified permits must include details of the arrangements made for air, water and land protection as referred to in this Directive.

Article 9: Conditions of the permit
Without prejudice to Article 10, the emission limit values and the equivalent parameters and technical measures referred to in paragraph 3 shall be based on the best available techniques, without prescribing the use of any technique or specific technology, but taking into account the technical characteristics of the installation concerned, its geographical location and the local environmental conditions. In all circumstances, the conditions of the permit shall contain provisions on the minimization of long-distance or transboundary pollution and ensure a high level of protection for the environment as a whole.
The permit shall contain suitable release monitoring requirements, specifying measurement methodology and frequency, evaluation procedure and an obligation to supply the competent authority with data required for checking compliance with the permit.

Article 11: Developments in best available techniques
Member States shall ensure that the competent authority follows or is informed of developments in best available techniques.

Article 13: Reconsideration and updating of permit conditions by the competent authority
Member States shall take the necessary measures to ensure that competent authorities periodically reconsider and, where necessary, update permit conditions.
The reconsideration shall be undertaken in any event where:
- the pollution caused by the installation is of such significance that the existing emission limit values of the permit need to be revised or new such values need to be included in the permit,
- substantial changes in the best available techniques make it possible to reduce emissions significantly without imposing excessive costs,
- new provisions of Community or national legislation so dictate.

Article 18: Community emission limit values
Acting on a proposal from the Commission, the Council will set emission limit values, in accordance with the procedures laid down in the Treaty, for:
- the categories of installations listed in Annex I except for the landfills covered by categories 5.1 and 5.4 of that Annex,

ANNEX I: CATEGORIES OF INDUSTRIAL ACTIVITIES REFERRED TO IN ARTICLE 1
2. The threshold values given below generally refer to production capacities or outputs. Where one operator carries out several activities falling under the same subheading in the same installation or on the same site, the capacities of such activities are added together.

1. Energy industries
   - 1.1. Combustion installations with a rated thermal input exceeding 50 MW (1)
   - 1.2. Mineral oil and gas refineries
   - 1.3. Coke ovens
   - 1.4. Coal gasification and liquefaction plants

2. Production and processing of metals
   - 2.1. Metal ore (including sulphide ore) roasting or sintering installations
   - 2.2. Installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting, with a capacity exceeding 2,5 tons per hour
   - 2.3. Installations for the processing of ferrous metals:
     - (a) hot-rolling mills with a capacity exceeding 20 tons of crude steel per hour
     - (b) smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power used exceeds 20 MW
     - (c) application of protective fused metal coats with an input exceeding 2 tons of crude steel per hour
   - 2.4. Ferrous metal foundries with a production capacity exceeding 20 tons per day
   - 2.5. Installations

(a) for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes
(b) for the smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) with a melting capacity exceeding 4 tons per day for lead and cadmium or 20 tons per day for all other metals
2.6. Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m^3

3. <u>Mineral industry</u>
3.1. Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tons per day or lime in rotary kilns with a production capacity exceeding 50 tons per day or in other furnaces with a production capacity exceeding 50 tons per day
3.2. Installations for the production of asbestos and the manufacture of asbestos-based products
3.3. Installations for the manufacture of glass including glass fiber with a melting capacity exceeding 20 tons per day
3.4. Installations for melting mineral substances including the production of mineral fibers with a melting capacity exceeding 20 tons per day
3.5. Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tons per day, and/or with a kiln capacity exceeding 4 m^3 and with a setting density per kiln exceeding 300 kg/m^3

4. <u>Chemical industry</u>
Production within the meaning of the categories of activities contained in this section means the production on an industrial scale by chemical processing of substances or groups of substances listed in Sections 4.1 to 4.6
4.1. Chemical installations for the production of basic organic chemicals, such as:
(a) simple hydrocarbons (linear or cyclic, saturated or unsaturated, aliphatic or aromatic)
(b) oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resins
(c) sulphurous hydrocarbons
(d) nitrogenous hydrocarbons such as amines, amides, nitrous compounds, nitro compounds or nitrate compounds, nitriles, cyanates, isocyanates
(e) phosphorus-containing hydrocarbons
(f) halogenic hydrocarbons
(g) organometallic compounds
(h) basic plastic materials (polymers synthetic fibers and cellulose-based fibers)
(i) synthetic rubbers
(j) dyes and pigments
(k) surface-active agents and surfactants
4.2. Chemical installations for the production of basic inorganic chemicals, such as:
(a) gases, such as ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride
(b) acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids
(c) bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide
(d) salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate
(e) non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide
4.3. Chemical installations for the production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers)
4.4. Chemical installations for the production of basic plant health products and of biocides
4.5. Installations using a chemical or biological process for the production of basic pharmaceutical products
4.6. Chemical installations for the production of explosives

5. <u>Waste management</u>
Without prejudice of Article 11 of Directive 75/442/EEC or Article 3 of Council Directive 91/689/EEC of 12 December 1991 on hazardous waste (2):

5.1. Installations for the disposal or recovery of hazardous waste as defined in the list referred to in Article 1 (4) of Directive 91/689/EEC, as defined in Annexes II A and II B (operations R1, R5, R6, R8 and R9) to Directive 75/442/EEC and in Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils (3), with a capacity exceeding 10 tons per day
5.2. Installations for the incineration of municipal waste as defined in Council Directive 89/369/EEC of 8 June 1989 on the prevention of air pollution from new municipal waste incineration plants (4) and Council Directive 89/429/EEC of 21 June 1989 on the reduction of air pollution from existing municipal waste-incineration plants (5) with a capacity exceeding 3 tons per hour
5.3. Installations for the disposal of non-hazardous waste as defined in Annex II A to Directive 75/442/EEC under headings D8 and D9, with a capacity exceeding 50 tons per day
5.4. Landfills receiving more than 10 tons per day or with a total capacity exceeding 25 000 tons, excluding landfills of inert waste

6. Other activities
6.1. Industrial plants for the production of:
(a) pulp from timber or other fibrous materials
(b) paper and board with a production capacity exceeding 20 tons per day
6.2. Plants for the pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibers or textiles where the treatment capacity exceeds 10 tons per day
6.3. Plants for the tanning of hides and skins where the treatment capacity exceeds 12 tons of finished products per day
6.4. (a) Slaughterhouses with a carcass production capacity greater than 50 tons per day
(b) Treatment and processing intended for the production of food products from:
- animal raw materials (other than milk) with a finished product production capacity greater than 75 tons per day
- vegetable raw materials with a finished product production capacity greater than 300 tons per day (average value on a quarterly basis)
(c) Treatment and processing of milk, the quantity of milk received being greater than 200 tons per day (average value on an annual basis)
6.5. Installations for the disposal or recycling of animal carcasses and animal waste with a treatment capacity exceeding 10 tons per day
6.6. Installations for the intensive rearing of poultry or pigs with more than:
(a) 40 000 places for poultry
(b) 2 000 places for production pigs (over 30 kg), or
(c) 750 places for sows
6.7. Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity of more than 150 kg per hour or more than 200 tons per year
6.8. Installations for the production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitization

ANNEX IV
Considerations to be taken into account generally or in specific cases when determining best available techniques, as defined in Article 2 (11), bearing in mind the likely costs and benefits of a measure and the principles of precaution and prevention:
1. the use of low-waste technology;
2. the use of less hazardous substances;
3. the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate;
4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
5. technological advances and changes in scientific knowledge and understanding;
6. the nature, effects and volume of the emissions concerned;
7. the commissioning dates for new or existing installations;
8. the length of time needed to introduce the best available technique;
9. the consumption and nature of raw materials (including water) used in the process and their energy efficiency;

10. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
11. the need to prevent accidents and to minimize the consequences for the environment;

2.2 COUNCIL DIRECTIVE 93/76/EEC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency (SAVE)

Article 1
The purpose of this Directive is the attainment by Member States of the objective of limiting carbon dioxide emissions by improving energy efficiency, notably by means of drawing up and implementing programmes in the following fields:

- energy certification of buildings,
- the billing of heating, air-conditioning and hot water costs on the basis of actual consumption,
- third-party financing for energy efficiency investments in the public sector,
- thermal insulation of new buildings,
- regular inspection of boilers,
- energy audits of undertakings with high energy consumption.

Programs can include laws, regulations, economic and administrative instruments, information, education and voluntary agreements whose impact can be objectively assessed.

Article 2
Member States shall draw up and implement programs on the energy certification of buildings. Energy certification of buildings, which shall consist of a description of their energy characteristics, must provide information for prospective users concerning a building's energy efficiency.

Article 5
Member States shall draw up and implement programs so that new buildings receive effective thermal insulation, taking a long-term view, on the basis of standards laid down by the Member States, taking account of climatic conditions or climatic areas and the intended use of the building.

Article 6
Member States shall draw up and implement programs on the regular inspection of heating installations of an effective rated output of more than 15 kW with the aim of improving operating conditions from the point of view of energy consumption and of limiting carbon dioxide emissions.

Article 10
1. Member States shall bring into force the laws, regulations and/or other measures as mentioned in Article 1 as necessary to comply with this Directive as soon as possible and not later than 31 December 1994. Member States are required to make all the necessary provisions to enable them to fulfill the objectives of this Directive.

2.3 COUNCIL DIRECTIVE 1999/31/EC of 26 April 1999 on the landfill of waste

Article 1: Overall objective
1. With a view to meeting the requirements of Directive 75/442/EEC, and in particular Articles 3 and 4 thereof, the aim of this Directive is, by way of stringent operational and technical requirements on the waste and landfills, to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life-cycle of the landfill.

Article 2: Definitions
For the purposes of this Directive:
(j) "landfill gas" means all the gases generated from the landfilled waste;

(m) "biodegradable waste" means any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard;

Article 5: Waste and treatment not acceptable in landfills
1. Member States shall set up a national strategy for the implementation of the reduction of biodegradable waste going to landfills, not later than two years after the date laid down in Article 18(1) and notify the Commission of this strategy. This strategy should include measures to achieve the targets set out in paragraph 2 by means of in particular, recycling, composting, biogas production or materials/energy recovery. Within 30 months of the date laid down in Article 18(1) the Commission shall provide the European Parliament and the Council with a report drawing together the national strategies.
2. This strategy shall ensure that:
(a) not later than five years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 75 % of the total amount (by weight) of biodegradable municipal waste produced in 1995
(b) not later than eight years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 50 % of the total amount (by weight) of biodegradable municipal waste produced in 1995;
(c) not later than 15 years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 35 % of the total amount (by weight) of biodegradable municipal waste produced in 1995.

ANNEX I, GENERAL REGUIREMENTS FOR ALL CLASSES OF LANDFILLS

4. Gas control

4.2. Landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected cannot be used to produce energy, it must be flared.

3 Czech legislation transposing SAVE and Landfill Directives

3.1 ACT No. 406, Coll. on energy management

The Act lays down rights and obligations of natural and legal persons in management of energy (electric power, gas and heat). It is focused on efficient use of natural resources, protection of environment, sustainable economic development, increase of energy efficiency and reliability of energy supply.
Act lays down state and regional energy concepts (§ 3 and 4) as obligatory planning tools prepared each 20 years. National program of efficient use of energy and utilization of renewable and secondary energy resources shall be reviewed in 2 year periods by the Ministry of Industry and Trade and the Ministry of Environment (§5).
Resources from State budget shall be used in following areas:

- measures increasing efficient use of energy,
- development of combined production of heat and electric power,
- modernization of production and distribution installations,
- introduction of modern materials and technologies,
- use of secondary and renewable energy resources,
- public awareness, education and professional training,
- research and development,
- preparation of regional energy concepts.

Provisions on energy saving are lain down by § 6 and 7. Efficient use of energy is specified by means of technical standards for new and reconstructed installations for energy production and use of energy in buildings (heat, hot water). Any new or reconstructed combustion source of heat with output 5 MWt or higher shall be operated in CHP regime (co-generation). Any new or reconstructed combustion source of electric power with output 10 MWe or

higher shall be operated in CHP regime (co-generation). Gas turbines with output greater than 2 MWe and stationary combustion engines with output greater than 0.8 MWe shall be operated in CHP regime.
Manufacturers and importers of electric appliances specified in a special regulation (decree) have to respect technical standards for energy efficiency and inform consumers by means labels on energy efficiency (§ 8). Labels shall bear information on energy efficiency and impact of human health and environment written in Czech language.
Technical installations and buildings are to be audited in cases specified by § 9. The audits shall be carried out by persons with professional qualification (§10).
Purpose of Act No. 406, Coll. is to transpose and implement relevant EU legislation, especially Directives 93/76/EEC, 92/42/EEC, 78/170/EC, 96/57/EC, 92/75/EEC and 96/92/EC.

3.2 ACT No. 185/2001 Coll. on Waste and change to some other Acts

This Act regulates

- prevention of waste generation and waste management under compliance with environmental protection, health protection and sustainable development,
- rights and obligations of persons active in waste management, and
- jurisdiction of public administration.

Waste is defined generally accordingly §3 as "any movable asset that a person is disposing of or has the intent or obligation to dispose of.
Waste generators are obliged to prevent or minimize waste generation, reduce hazardous properties of the waste, reuse, recycle or dispose waste under conditions, which neither affect environment negatively nor possess risk to human health (§10). Material and energy use of waste is a priority (§11).
Accordingly to § 12, waste may only be managed only in facilities designed and licensed for waste management pursuant to this Act. Pollution limits stipulated by special legal regulations must not be exceeded. The ministry shall issue a decree specifying the operational conditions for landfills incl. collection of landfill gas.
When transferring waste, waste generator is obliged to learn whether the person to whom the waste is being transferred is licensed under this Act. Diluting or mixing waste for the purpose of compliance with criteria for its acceptance to landfill and/or mixing hazardous waste with other hazardous or other waste is forbidden.
Waste generator and licensed person managing hazardous waste are obliged to ensure that hazardous waste is packed and labeled accordingly to the Act (§ 13).
Accordingly § 16, waste generator is obliged to:

- classify waste by types and categories pursuant to §5 and 6,
- ensure waste utilization priority pursuant to §11,
- collect waste sorted by types and categories,
- safeguard waste and protect it against harmful impairment, misappropriation or leak,
- keep operating records on waste and the waste management methods, file waste reports and submit to the respective administrative office further information within the scope specified by this Act. These records must be archived over a period of time specified by this Act or related regulation,
- enable inspection bodies access into facilities and if requested, submit documentation and provide correct and true information in relation to the waste management.

4 FACE AIJ Projects - Forest rehabilitation in Krkonose and Sumava National Parks

Project FACE has been launched in 1992 continuing until now. The aim of the project is to eliminate partially deforestation caused by atmospheric emissions from brown coal combustion, which started to influence negatively Czech forests since 70s. Three operational plans have been implemented up to now (1st in 1992-4, 2nd in 1995-7) ; the third one has been completed by the end of 2000. In total, 5 220 hectares of forest have been rehabilitated in Krkonose National park with support of FACE amounting 350 million of CZK (ca 10 million USD). The FACE Foundation has been awarded by the Czech Minister of the Environment, Mr. Milos Kuzvart, in 2000.

Krkonose activities:
Area to which Face wishes to contribute: 9,000 ha
Goal for period 19921997: 3,855 ha
Area planted as at 311296: 2,700 ha

The Giant Mountains (Krkonose) lie in the centre of the so-called Black Tringle. The great increase in acidifying deposits in the period 1950 to 1990 resulted in large scale death or morbidity of trees in this area on the borders of the Czech Republic, Poland and the former DDR. The restoration of Krkonose National Park in the Giant Mountains commenced back in 1992. The first phase of that project has been completed and 1,352 ha of forest have been restored by planting mainly Norway spruce, beech and elderberry. In the second contract term of the reforestation project in Krkonose the initial recommendations resulting from the research carried out by the Department of Physical Geography of the University of Amsterdam, and the Opoçno Forestry Research Station have been implemented. It has been concluded (partly on the basis of these results) that several locations will recover spontaneously in the next few years. The condition of several other areas is such, however, that it is doubtful whether new plantings will succeed. The areas in these two categories have therefore been removed from the envisaged project area.

Sumava activites:
Area to which Face wishes to contribute: 5,000 ha
Goal for period 19951997: 1,200 ha
Area planted as at 311296: 818 ha

The restoration of the Sumava National Park was started in 1995 in accordance with the agreements made with Czech Ministry for the Environment. The reduction of the area to be planted in the Giant Mountains is entirely compensated for by the restoration of the Bohemian forest (Sumava). The Sumava National Park lies on the border between the Czech Republic and the German federal state of Bavaria. It is 69,000 ha in area (including its border zones), of which 55,000 ha of forest lies in a protected area. Together with the Bavarian Forest across the border, this protected area, which is also known as the Bohemian Forest, is 82,100 ha in extent. Reforestation with monocultures in the last century and the increase in air pollution have resulted in the vitality of large areas of forest declining dramatically. Further research has shown that this deterioration is partly attributable to the planting of nonadapted species. These adult trees are not optimally suited to the conditions of this low mountain range, making them an easy prey for bark beetles such as the spruce bark beetle. The managers of the National Park are now selecting seeds for the new planting material from the remaining original trees. In total, 5,000 ha need to be restored. In the current threeyear phase Face will provide financial support for the reforestation of 1,200 ha in Sumava.
Source: http://www.unfccc.int/program/aij/aijact/czenld01.html

5 The list of all individual measures by sectors including their applicability as JI projects

Sector	Object	Measure	CO2 reduction (tones)	Suitable as JI project
Households	Pumps	Replacement by pump with electronic control of time schedule and pressure	-561 526	NO (1)
	Small electric heating boiler	Replacement by heat pump	-196 876	
	Surrounding walls	Insulation to the level recommended by the Czech standard	-3 554 642	
	Windows	Additional glazing	-593 155	
	Flat roofs	Insulation to the level recommended by the Czech standard	-401 431	
	Pipelines	Insulation in non-heated rooms	-208 549	NO (2)
	Manual valves	Replacement by valves with programmable head	-1 580 285	
	Ceilings above non-heated space	Insulation to the level recommended by the Czech standard	-29 361	
	Ceilings above non-heated basement	Insulation to the level recommended by the Czech standard	-50 193	
	Ceilings under non-heated loft	Insulation to the level recommended by the Czech standard	-609 971	
	Slant roofs above heated attic	Insulation to the level recommended by the Czech standard	-529 218	
Households Total			**-8 315 207**	
Transport	Freight road transport	Switch to rail transport (20 %)	-15 755	NO (1)
	Trains in diesel freight rail transport	Replacement by electric trains	-5 169	NO (1)
Transport Total			**-20 925**	
Municipal energy sources	Four-piped secondary networks in channels	Replacement by two-pre-insulated pipe networks without channels	-69 735	
	House exchange stations with decentralised hot water heating	Rehabilitation	-27 295	NO (2)
	Two-piped hot water distribution networks in channels	Replacement by networks without channels	-117 865	
	Steam networks	Switch to hot water networks	-18 005	
	Pressure-dependent heat exchange station	Improvement of insulation	-213	NO (2)
Municipal energy sources Total			**-233 113**	
Renewables	Biomass	Wood-fired cogeneration	-198 364	NO ½ (2)
		Boiler burning cereal and rape straw (300 kW - 1 MW)	-92 787	
		Boiler burning woodchips (up to 300 kW)	-40 067	
		Heating plant burning wood and wood wastes (500 kW - 3 MW)	-68 047	
		Heating plant burning cereal straw (above 1 MW)	-135 359	
		Heating plant burning woodchips (500 kW - 3 MW)	-64 130	
	Biogas	Biogas-fired cogeneration	-101 691	NO (2)
	Municipal wastes	Burning of municipal wastes – electricity and heat production	-170 909	NO (2)
	Solar energy	Solar system with hot air collectors	-303 586	
	Wind energy	Wind power plant above 100 kW (600 kW) connected to network - wind speed up to 4,8 - 5 m/s	-147 337	
		Wind power plant above 100 kW (600 kW) connected to network - wind speed 5 - 6 m/s	-643 388	
		Wind power plant above 100 kW (600 kW) connected to network - wind speed above 6 m/s	-117 336	
	Hydro energy	Small hydro power plant 200 kW - 10 MW	-535 066	
		Small hydro power plant up to 200 kW	-63 612	
Renewables Total			**-2 681 679**	
Industry	Electric drives	Implementation of advanced electric motors EEM type with high energy	-46 801	

Sector	Object	Measure	CO2 reduction (tones)	Suitable as JI project
		efficiency		
	Coke oven	Improvement of temperature control	-29 797	NO (3)
	Heating furnaces	Replacement	-85 093	
	Gas-fired boilers	Installation of small CHP plants with gas engines - up to 50 MW	-1 793 806	NO ½ (2)
		Installation of small CHP plants with gas turbines - above 50 MW	-568 809	NO ½ (2)
		Installation of small CHP plants with gas turbines - up to 50 MW	-2 681 259	NO (2)
	Drying wood in stream dryers	Replacement by condensing driers with utilisation of heat pumps	-9 566	
	Plants with low-potential waste heat	Organic Rankin cycle	-110 915	
		Absorption heat pumps	-102 730	
		Compressor heat pumps with electric motors and hybride heat pumps	-76 866	
	Industrial halls	Heating of industrial halls by light gas radiator heaters	-532 224	
		Heating of industrial halls by dark gas radiator heaters	-465 696	
	Drying milk, milk products, instant drinks, detergents and washing powders products in spray dryers	Adding of final drying in vibro-fluid through	-1 430	NO (3)
	Drying crystalic materials (e. g. borax, boric acid) in plate dryers	Replacement by stream dryers	-2 078	NO (3)
	Drying granulated metters (e. g. medicaments) in cabinet dryers	Replacement by periodic fluidization dryers	-1 664	NO (3)
	Drying dyes and colour semi-products in vacuum dryers	Replacement by spray (atomizer) dryers	-1 645	NO (3)
	Production of vinylchloride	Switch to oxygen oxychlorization	-43 632	NO (3)
	Propylene production	Upgrading of process equipment	-50 181	NO (3)
Industry Total			**-6 604 191**	
Tertiary sector	Pumps	Replacement by pump with electronic control of time schedule and pressure	-55 911	NO (1)
	Small electric space heating boiler	Replacement by heat pump	-5 111	
	Surrounding walls	Insulation to the level recommended by the Czech standard	-216 631	
	Windows	Additional glazing	-51 384	
		Additional glazing and sealing of gaps	-4 682	
	Flat roofs	Insulation to the level recommended by the Czech standard	-36 316	
	Piping	Insulation in non-heated rooms	-5 858	NO (2)
	Manual valves	Replacement by valves with programmable head	-139 201	
	Ceilings above non-heated space	Insulation to the level recommended by the Czech standard	-7 793	
	Ceilings above non-heated basement	Insulation to the level recommended by the Czech standard	-5 898	
	Ceilings under non-heated loft	Insulation to the level recommended by the Czech standard	-38 155	
	Slant roofs above heated attic	Insulation to the level recommended by the Czech standard	-1 950	
Tertiary sector Total			**-568 891**	
Agriculture	Surrounding walls	Insulation	-22 594	
	Floors on the terrain	Insulation	-66 528	
	Distribution of hot water	Circulation	-439	
	Roofs	Insulation	-16 946	NO (2)
Agriculture Total			**-106 507**	
TOTAL			**-18 530 512**	

Note: 1. Problematic monitoring and assessment process.

2. This type of measures could be included into baseline scenario for example due to the new Energy Management Act which sets a minimal level of heat generation and distribution efficiency, the obligation of CHP production etc.)
3. It could be regulated under IPPC directive

6 Projection of SMW and biodegradable waste

There are correlations between GDP and SMW generation over groups of countries with similar production and consumption patterns[2]. Trying to derive a plausible projection of SMW generation till 2010, we have used correlations between GDP and SMW for 10 EU candidate countries (CEECs) and EU members (1998 data). Slopes and intercepts of simple linear regression are given in Table 1.

Table 1: Linear regression and correlation between GDP and SMW[3]

Countries	Intercept y-axis (kg of SMW)	Slope (kg of SMW/1000 EURO)	Correlation coefficient Critical value (99%)
EU (n=14)	107.4	17.6	0.7692/0.661
CEECs (n=10)	182.8	26.4	0.7702/0.765

Despite the differences in collection efficiencies and in composition of municipal waste (e.g. varying share of commercial waste from SMEs, ashes in areas with coal-heated houses, packaging waste etc.), there is a strong correlation between those two indexes.

Consequently, CEECs seem to generate in average more SMW per unit of GDP than the EU countries. The statistical model predicts e.g. for the Czech Republic, where ca 4% growth of GDP is expected till 2010, that SMW generated will grow by more than 30 % if any preventive measures are not taken (BAU). Using the GDP projection derived for strong economic growth and assumption that the slope of the linear dependence between GDP and SMW will linearly decrease (Eq. 1) with time t (years) from above 26.4 kg/1000 EUR (CEECs average) to EU average 17.4 kg/1000 EUR between 2000 and 2010, we have obtained WMP projection.

SLOPE = 26.4 – 0.9t **Eq. (1)**

In Table 2, there is a calculation of growth of GDP and SMW for two-year periods between 2000 and 2010. We have compared our results with ETC/W study[4] on waste projections of EU countries expressed as relative growth (%). For Austria, there is a projected annual increase of 3.27% between 2000 and 2010, while for the Netherlands this increase is estimated even as 4.07%. Taking 450 kg/inhab. as officially reported SMW generated in the Czech republic (1998), the estimated BAU generation in 2010 is ca 625 kg/inhab., which corresponds to annual growth of 3.9%.

Table 2: Growth of GDP and SMW between 2000 and 2010, BAU

Year	Increment of GDP[5] (thous. EURO/inhab.)	SLOPE (kg/1000 EURO)	Increment of SMW (kg/inhab.)
1998	0	26.4	0.0
2000	400	26.4	10.6
2002	1600	24.6	29.5
2004	3400	22.8	41.0
2006	5200	21.0	37.8
2008	6800	18.6	29.8
2010	8900	17.4	36.5
Total (2000-2010)	-	-	174.6

[2] ETC/Waste, „Baseline projections of selected waste streams“, (Technical Report 28), Copenhagen, http://etc-waste.eionet.eu.int/

[3] see final report „Waste management policies in CEECs“, available at http://www.eurowaste.org

[4] ETC/Waste, „Baseline projections of selected waste streams“, (Technical Report 28), http://etc-waste.eionet.eu.int/

[5] GDP growth is taken from scenario of economic development (related to 1998) and recalculated to EURO/inhab. using reference value (EUROSTAT) expressed in purchase power standard (PPS), 12 200 EURO/inhab. in year 1998

As 41 % of SMW is biodegradable (estimate from 1998), there will be 256 kg/capita of this waste generated in 2010. This BAU projection does not take into account disposal structure, which must shift from landfilling to incineration and composting. The disposal scenarios presented in PHARE study are based upon requirements of landfill directive. Even for lower SMW growth projected (2.6 or 1.7 % annually) in the PHARE project[6], a substantial investment is expected into incineration and composting.

[6] PHARE Project No. CZ9811-02-02, Navrh strategie implementace a investic pro nakladani s odpady (Draft implementation and investment strategy for waste management), in Czech, Vol. 4, 2001, AEA Technology.