HELIO INTERNATIONAL

UKRAINE

Sustainable Energy Watch
2002 Report

Energy and Sustainable Development in Ukraine

The distroyed Chernobyl reactor

by

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Ukraine inherited low energy efficiency from the Soviet Union era. Energy demand has been falling dramatically and is just now starting to increase.

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Summary

This report was prepared for Sustainable Energy Watch (SEW)[1] to assess Ukrainian energy use in relation to the impact on Global Climate. SEW methodology is used for assessment based on 8 indicators.

The Ukraine became independent in 1991 following the break-up of the former USSR. Since then the Ukrainian economy has experienced a dramatic decline. Slow economic and political reforms so far have not facilitated the economic recovery. Last year, however, the Ukrainian GDP showed growth for the first time in ten years.

Ukraine inherited from the USSR a fairly developed energy sector with wide network of electricity, heat and gas delivery. On the other hand, the 'command and control' economy of the Soviet Union diminished the role of economic sense, leading to inefficient energy use. Economie decline led to decline in overall energy demand. Today, the Ukraine consumes half of the energy it consumed in 1990. The country's GDP today is less than half of 1990 level.

The economic crisis created a situation where Ukrainian emissions of CO_2 today are lower than the 1990 level. However, when the recovery of the economy finally takes place, the Ukraine will easily rise above the current target set by the Kyoto Protocol. This will occur, for one reason, because highly energy intensive industries such as metallurgy are a core of the current Ukrainian economy.

Even still, the Ukrainian economy consumes much more energy than the average in the world. The tendency in the past was to increase energy consumption. Ukrainian government has declared energy saving as a major energy strategy. However, this decision has hardly been implemented. Energy consumers lack of incentives for effective use of resources. End-use consumers often pay too little or do not pay at all for the energy consumed.

Renewables are seen as one of the major ways to reduce the country's dependence on energy import. Ukraine heavily depends on Russia in delivery of all energy products, except coal. However, Ukrainian coal is of bad quality leading to low efficiency and leads to the fast degradation of the coal-fired power plants. At the same time, Ukraine has tremendous potential for developing wind power generation and small hydro. Developing local renewable sources would decrease dependence on energy imports. Due to the electricity shortage many Ukrainian provinces experience rolling blackouts. Small local renewable sources will help local authority gain independence from central electricity grid.

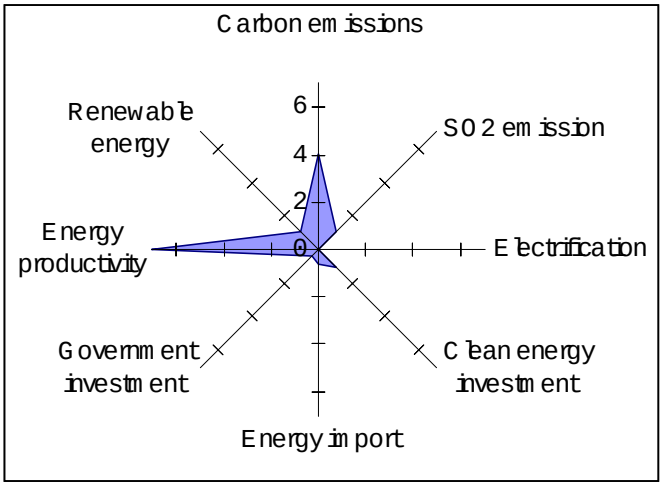
To summarize, most of the positive trends described in this report are misleading and are caused by the economic crisis in Ukraine. The only exception is development of electricity grid. Ukraine requires urgent steps to reduce it's energy intensity and develop renewable sources of energy.

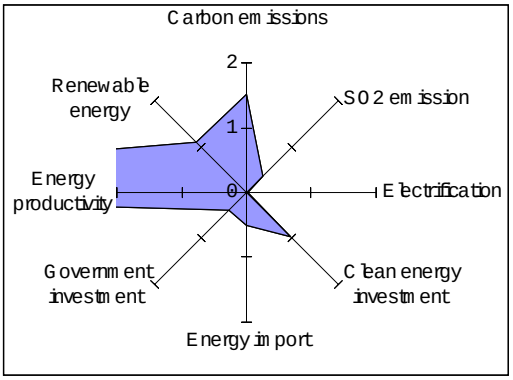
[1] The Sustainable Energy Watch of Helio International. See <www.helio-international.org>

Eight Indicators of Energy Sustainability for Ukraine

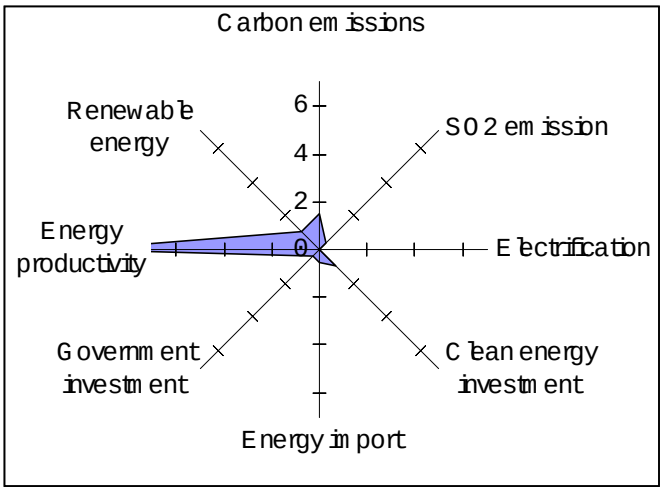
	Eight Indicators of Energy Sustainability for Ukraine						
	1990		1999 (1995)			% of Change	
	Metric	Vector	Metric	Vector	*Year*	Metric	Vector
1. Carbon emissions	3,512 kgC/cap	4.011	1,541 kgC/cap	1.520	*1999*	-56.12	-62.10
2. Local pollutant (SO_2)	48.7 kg/cap	1.100	15.3 kg/cap	0.349	*1999*	-68.58	-68.27
3. Households electrification	99%	0.010	99%	0.010	*1999*	0	0
4. Clean energy investment	0	1.000	30 m USD	0.960	*1998*	-	-0.04
5. Resilience: energy import	5,350.5 PJ	0.600	3,130.8	0.510	*1995*	-41.49	-0.15
6. Government investment	n.a.	~0.400	1.25 bln USD	0.380	*1999*	-	-0.05
7. Energy productivity (energy consumption/GDP)	67.97MJ/ USD	6.980	97.95 MJ/ USD	10.120	*1995*	69.39	31.02
8. Renewable energy	0%	1.100	0.08%	1.099	*1999*	0.08	-0.001

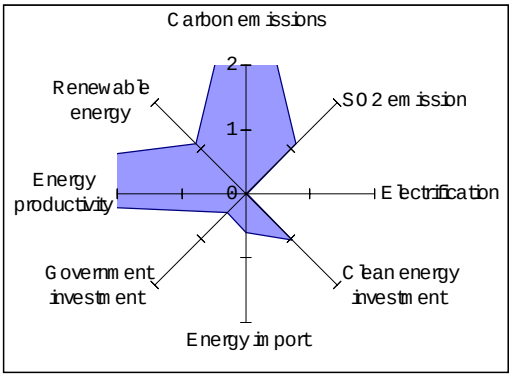
Ukraine's Star
1990 Vectors





Ukraine's Star
1999 Vectors





Introduction

The Sustainable Energy Watch (SEW) report for Ukraine was completed in 2001 for the first time, using SEW's methodology[2] is used to calculate indicators.

In preparing the report, a combination of national sources and data from international organisations as the OECD, World Bank and the EU's TACIS Programme, were used. Since different methodologies are used by the different sources, some data may not correlate correctly. Unfortunately, the authors were not able to find all data for the same year, making it difficult to do comparisons. However, all indicators are calculated for 1990. Data for the later years shows the trend for value change.

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[2] The Sustainable Energy Watch of Helio International. See <www.helio-international.org>

Ukraine and the Energy Sector at a Glance

Population	49.7 million	(1999)
Population growth (annual %)	-0.8	(1999)
Currency	Hryvna	
Exchange rate	UAH 5.43=USD 1	(2000)
GDP at market prices (billion USD of July 2000)	42	(1999)
GNP per capita, Atlas method (USD of July 2000)	750	(1999)
Inflation	25%	(2000)
Annual CO_2 Emissions		
CO_2 Emissions FCCC Base year (m tones CO_2)	711	(1990)
Energy Consumption (PJ)	6,878.1	(1995)
Energy Import (PJ)	3,130.8	(1995)
Energy Intensity (MJ/USD)	97.95	(1995)
Electricity Consumption (TWh)	166.8	(2000)

►General Discussion of Ukraine

Geographic location: Eastern Europe, between Poland and Russia, bordering the Black Sea.
Total area: 603,700 sq. km (app. 240,000 sq. mi.). Comparative area: slightly bigger than France.
Natural resources: iron ore, coal, manganese, natural gas, oil, salt, sulphur, graphite, titanium, magnesium, kaolin, nickel, mercury, timber.
Land use. Arable land: 56%. Irrigated land: 26,000 sq. km (1990).
Environmental issues: air and water pollution, inadequate supplies of potable water, radiation contamination in the north-east from 1986 accident at Chernobyl Nuclear Power Plant, deforestation.

Ukraine achieved its independence in 1991 following the break-up of the USSR. Since then the Ukrainian economy has experienced a dramatic decline. Slow economic and political reforms did not facilitate economic recovery. Last year Ukrainian GDP showed growth for the first time in ten years.

On one hand, the Ukraine inherited a highly educated population, a good health care system, and well-developed energy and public transport infrastructures. On the other hand, the country has a high level of corruption and political unrest. The Ukraine used to have modern industries. However, these industries were attached to the military industry and are now in stagnation. The economy has shifted to industries with high-energy consumption like metallurgy.

▸Energy policy

The Ukraine has about 55 GW of installed generation capacity and about 50 million people, but faces a serious and growing energy crisis. Since its independence in 1991, Ukraine's energy utilities have not been able to recover their costs, quality of service has deteriorated, and thermal and hydro plants badly need refurbishing. The average retail electricity price tripled from 1994 to1997, reaching $39/MWh, which is close to its economic costs. Electricity cost per capita has increased dramatically, and the percentage of utility income received in cash has declined. Real per-capita income has declined as well.

Two results of this are political pressure to keep prices artificially low and an enormous non-payment problem. The non-payment problem is exacerbated by special government sanctions that remove the obligation to pay electricity bills for a broad host of groups. The non-payments problem is joined by a cash-collections problem that requires barter to provide compensation for electricity and fuel.

Ukraine's high-energy intensity and low end-use efficiency make it highly dependent on electricity production. The current electricity economy relies heavily on nuclear power (50%), imported oil and gas from Russia and Turkmenistan, and low quality domestic coal. Its thermal power plants, including combined heat and power units, have an average efficiency of approximately 10,355 Btu/kWh.

Thermal plants have insufficient funds to procure fuel, have low average utilisation rates (30-35% capacity factors), and Ministry for Fuel and Energy controls daily plant dispatch. Most of these plants lack controls and cannot follow load, which contributes to frequency fluctuations and use of load curtailment to reduce low frequency excursions.

Electricity exports are limited (to Poland, Moldova, and Russia), largely because the Ukraine grid cannot maintain frequency (50 cycles) within acceptable limits (+/- .025 cycles). This limits Ukraine's ability to benefit from electricity trade and interconnection for reliability and ancillary services.

The political context is one where key decision-makers lack the will to implement real reforms. Any possible market forces, for example, have been muted completely by centralised control or routine government intervention. In short, energy policy lacks certainty and the necessary legal institutions and laws to implement so-called "twin sector approach" to mitigate energy related environmental issues.

►Environmental policy

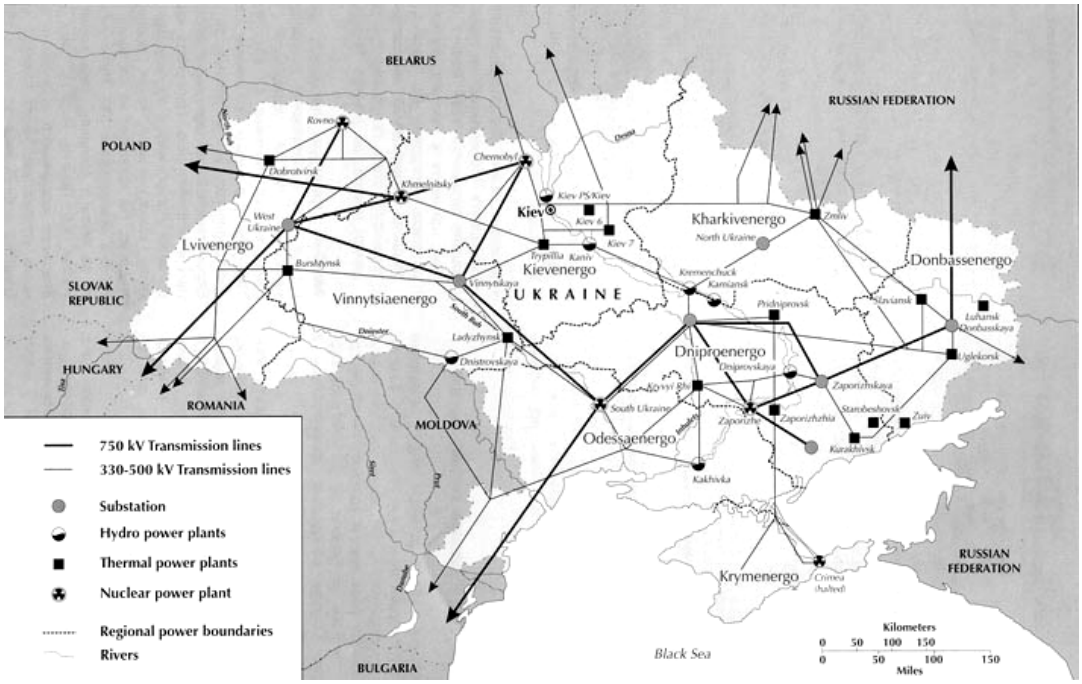
Since its independence, in response to significant environmental deterioration, the country adopted basic environmental legislation and proclaimed the introduction of a new environmental policy. These are often very general statements of policy, many of which refer to the importance of "command-and-control" approach. Few of these policy statements are, however, based on holistic approach to economy/ environment interactions during the transition period or backed up by specific legislation, obligations and resources.

In June 1991 Verkhovna Rada (the Parliament) adopted a general environmental law -- the Law on the Protection of the Environment. The provisions of the law touch on nearly all aspects of environmental management and state very idealistic goals, but define few clear commands or enforcement mechanisms. Unfortunately, as with legislation of the past, the law remains primarily a declarative document.

In 1992 Parliament announced the whole territory of the country as a zone of environmental disaster. This merely political declaration had a very limited environmental outcome, as it did not clearly delineate process or authority for specific activities, and it did not set priorities or deadlines. Moreover, it was not based on the well-structured National Environmental Action Plan.

In spite of the provisions of the UNCED, the National Agenda 21 or any other equivalent document has not been adopted by the Parliament.

Map1. Major Power Stations and Transmission lines in Ukraine



Environmental sustainability

►Indicator 1: Per capita energy sector CO2 emissions

Vector Value Calculations:
Ukraine's total emissions of carbon in metric tones from energy combustion in1990 = 182.272 mtC [3]. Ukraine's population in 1990 = 51.9 m. Ukraine's 1990 emissions per capita = 3,512 kgC/cap [4]

Ukraine's total emissions of carbon in metric tones from energy combustion in1999 = 76.61 mtC [5]. Ukraine's population in 1999 = 49.7 m. Ukraine's 1999 emissions per capita = 1,541 kgC/cap

Vector Value:
1999 vector value = (1,541 kgC/cap - 339 kgC/cap)/791 kgC/cap = **1.520**
1990 vector value = (3,512 kgC/cap - 339 kgC/cap)/791 kgC/cap = **4.011**

It should be mentioned that this trend is very delusive. The Ukrainian government tries hard to subsidise energy consumption in the most carbon intensive sectors of national economy. The emerging market in Ukraine eliminated some of the wasteful demand typical of centrally planned economies (such as over consumption of fuels and power, raw materials and transportation.) An appropriate fall in output attributable to the elimination of the worst loss-making activities may even be desirable for the environment as a whole. Unfortunately, those activities in many cases are precisely the ones that, through the over use of energy and natural resources and through pollution in production and consumption, allow earn foreign exchange, fig.1.1. That is why national government continues to subsidise carbon intensive exports through tax exemptions, low emissions charges and various indirect subsidies.

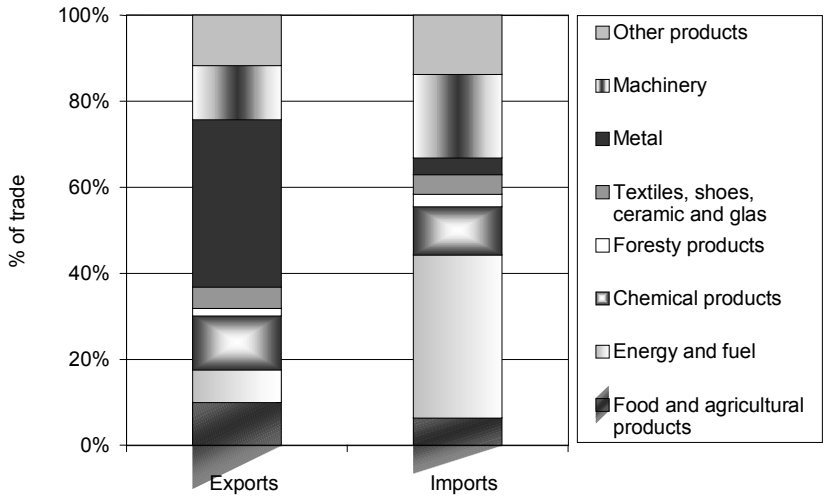


Figure 1.1. Ukraine's trade by product group [6] (1998, in %)

[3] Ukraine: The first national communication on climate change. Kyiv. 1998. It should be mentioned that the country never reported official CO2 emissions estimates before 1998. It is widely agreed that the country was accounted for 17% (180 MtC) of emissions from the former Soviet Union in 1990.
[4] Energy policy of Ukraine. OECD. 1996 gives another data: 13.78 t of CO2 or 3.758 t of C
[5] Calculations are based on First national communication on climate change. Kyiv. 1998 and estimates of Michael Mondshine, Mary Harris, Natalya Parasyuk and Konstantin Yemelianov, Climate Change Policy Development in Ukraine: An Evaluation of Existing Administrative Structures for Addressing Climate Change and Recommendations for Strengthening these Administrative Structures. May, 2000.
[6] Ukraine's Economic Trends, Intelnews/Aug. 12, 1999.

Since the launch of economic reforms and until now there has not yet to be any signs of increased efficiency in the use of energy resources. Ukraine's energy intensity in terms of GDP has actually risen by a factor of 1.56, while it has fallen in other transitional economies, fig 1.2. This is a direct result of subsidising carbon intensive sectors of the economy. Indeed, if goods and services need not be paid for their full market prices, then it will not provide an incentive to conserve resources, and no savings will be achieved.

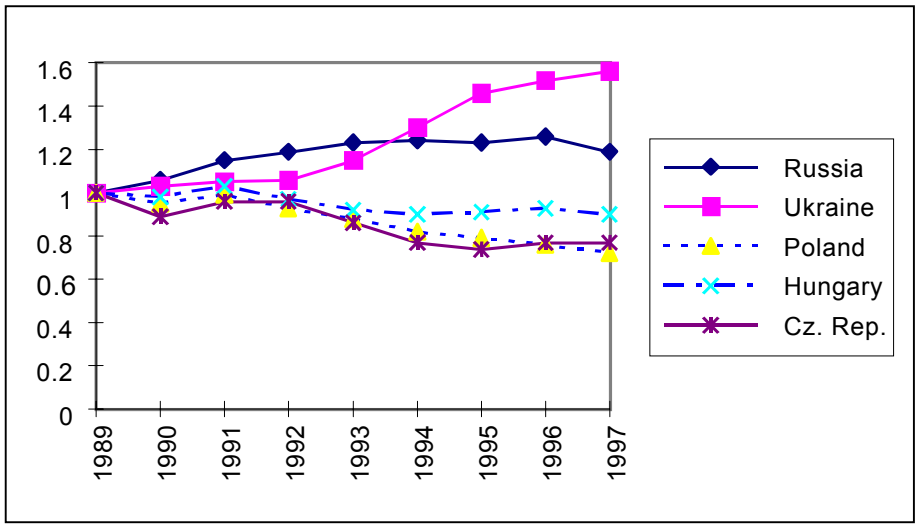


Figure 1.2. GDP energy intensity by international comparison [7]

In July 1999 President Kuchma signed the Law "On Experiment in Mining and Metallurgical Sectors of Ukraine" that gave carbon intensive and polluting industries highly favourable tax and emissions charges breaks. Here are two more demonstrative examples. First, just recently our President signed the Law "On Changes to Several Laws of Ukraine Regarding the Taxation of Extraction and Selling of Rude Oil and some of its Derivatives", No.1962-III of September 21, 2000. In accordance with the law, a zero level custom duties on imported oil and zero level VAT on domestic oil have been set up. Second, in the State Budget of Ukraine for year 2001 subsidies for the fuel and energy resources consumption have been increased for 760 m UAH (or in 60%).

Current subsidies in the Ukrainian economy encourage over-consumption of energy and material resources. By distorting the market prices, subsidies tilt the playing field in favour of more resource-intensive technologies, penalising efficiency measures and renewable energy sources. They also delay the adjustment that normally takes place as a commodity becomes scarcer. Moreover, the policy of "dirty" subsidies caused environmentally-unfriendly structural changes in Ukraine's economy (see table 1.1 – next page).

[7] German Advisory Group on Economic Reforms with the Ukrainian Government.

Table 1.1. Structure of Ukraine's industrial output within the two groups of sectors [8], %

Groups of industrial sectors	Share in output, %		
	1991	1994	1998
I group Fuel and energy complex, ferrous metallurgy, chemical, petrochemical and cement industry	23.2	49.5	55.8
II group Machine building and metal processing, forestry and Wooden industry, light and food industry	76.8	50.5	44.2
Total	100.0	100.0	100.0

We elaborated two scenarios of future structural changes in Ukraine's industry: BAU scenario and «clean» scenario, table 1.2:

Table 1.2. Two scenarios of structural changes in Ukraine's industry

Type of scenario	Share of output, %		
	2005	2010	2015
BAU scenario:			
I group	60	66	75
II group	40	34	25
Total	100	100	100
«Clean» scenario:			
I group	45	35	30
II group	55	65	70
Total	100	100	100

Both scenarios allow keeping the same dynamics of GDP growth, but emissions of energy related carbon would be substantially different (fig. 3) as the two groups of sectors suppose different energy intensity.

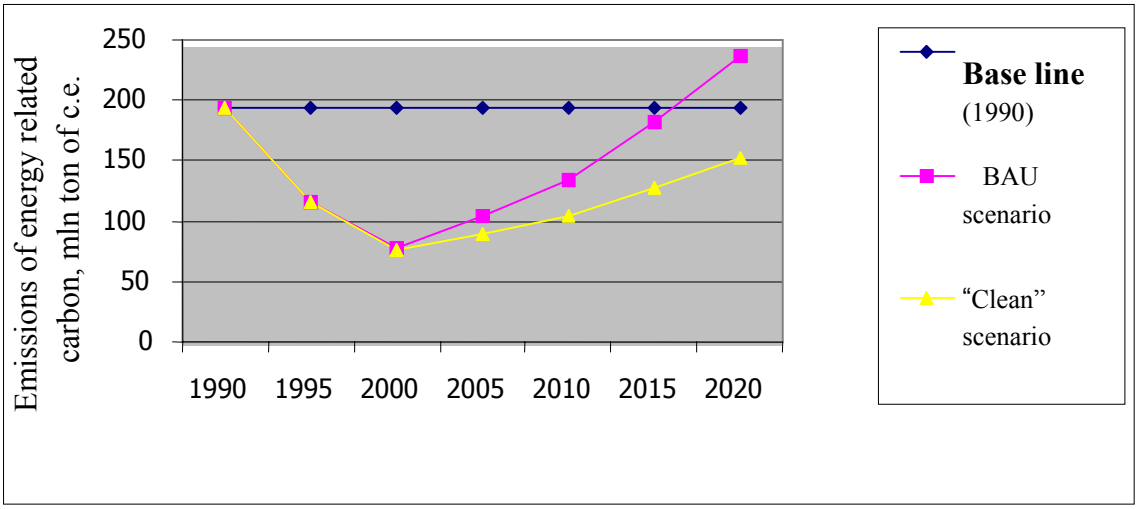


Figure 1.3. Forecasts of carbon emissions in accordance with BAU and "clean" scenarios[9]

[8] Mykola Chumachenko. Problems of Structural Policy in Ukrainian Industry/ Proceedings of the VII International Conference «Features of Economic Policy of Post-socialist Countries under the Globalization; A Case Study of Ukraine». Kyiv, Nov. 25-26, 1999.

[9] Modeling of scenarios and assessment of carbon emissions has been made by Vladimir Dounaev on the base of Victoria Software.

►Indicator 2: Most significant energy-related local pollutants

Vector Value Calculations:

Ukraine's 1990 total emissions of SO_2 in metric tonnes from fossil fuel combustion at TPP = 2.53 Mt [10]. Ukraine's population in 1990 = 51.9 million. Ukraine's 1990 SO_2 emissions per capita = 48.7 kg/cap.

Ukraine's 1999 total emissions of SO_2 in metric tones from fossil fuel combustion = 0.76 Mt [11]. Ukraine's population in 1999 = 49.7 million. Ukraine's 1999 SO_2 emissions per capita = 15.3 kg/cap

1990: 48.7 kg of SO_2 per capita, and in 1999: 15.3 kg of SO_2 per capita. The sustainability objective is one-tenth of 1990, or 4.87 kg SO_2 per capita. Zero to one vector value equals 48.7 - 4.87 = 43.83 kg SO_2 per capita.

Vector Value:

1990 = 48.7 / 43.83 = **1.100**
1999 = 15.3 / 43.83 = **0.349**

Again, this trend is delusive. If we compare GDP growth data (table 2.1) with dynamics of SO_2, NOx and particulate matters emissions in fuel and power sector (tables 2.2, 2.3), we can conclude that de-coupling of industrial growth and emissions is still a mirage.

In 1992-1997 Ukraine reduced its sulphur dioxide emissions mainly due to general decline of its economy.

Table 2.1. GDP as a key macroeconomic indicator (% change from previous year)[12]

	1992	1993	1994	1995	1996	1997	1998	1999	2000
Growth, %	-16.8	-14.0	-23.0	-12.5	-10.0	-3.2	-1.7	-0.4	6.0

It should be mentioned that the failures to impose the polluter pays principle also could be regarded as a subsidy. The difference between the EU rates of emission charges of energy-related pollutants, and Ukraine's rates could be considered as implicit subsidies, table 2.4.

[10] Ukraine: Suggested priorities for environmental protection and natural resource management. World Bank Report No. 12238-UA. 1993.

[11] State of the environment in Ukraine for 1999. National Report. Kyiv. 2000.

[12] Statistical yearbook of Ukraine, Ukrainian economic survey and others.

Table 2.2. Dynamics of SO_2, NO_X, hydrocarbons and VOCs emissions in fuel and power industry in 1997-1998 [13].

Criteria pollutant	Yearly emissions, kt		Share of total emissions	Change of emissions (as compared to the previous year)	
	1997	1998	%	kt	%
SO_2	780.6	718.3	70.2	-62.3	-8.0
NOx	209.0	187.7	56.4	-21.3	-10.2
Hydrocarbons and VOCs	4.3	2.2	0.5	-2.1	-48.8

Table 2.3. Dynamics of SO_2, NO_X hydrocarbons and VOCs emissions in fuel and power industry in 1998-1999 [14].

Criteria pollutant	Yearly emissions, kt		Share of total emissions	Change of emissions (as compared to the previous year)	
	1998	1999	%	kt	%
SO_2	718.3	761.3	74	+43.0	+6.0
NOx	187.7	193.4	58.1	+5.7	+3.0
Hydrocarbons and VOCs	2.2	3.4	0.8	+1.2	+54.5

Table 2.4. Selected emission taxes/charges of EU Member States and Ukraine[15] (1999).

	EUR/□ SO2	EUR/□ NOx	EUR/□ CO2
Denmark	5400.00		13.40
France	27.40	22.90	
Italy	53.20	105.00	
Sweden	6940.00	4630.00	42.80
Ukraine	9.63	9.63	

In the practice of environmental policies an increasing number of Western European countries have implemented taxes based on energy/carbon content of the energy products and services (Sweden, Norway, The Netherlands, Denmark, Finland, Austria, Germany and Italy). Several other countries, like Switzerland, France and the United Kingdom, are currently discussing proposals for their implementation.

[13] State of the environment in Ukraine for 1999. National Report. Kyiv. 2000.

[14] Ibid.

[15] Cabinet of Ministers Decree "On Emission Charges Base and Rates", No. 303, 1 March 1999. http://europa.eu.int/comm/dg11/enveco/index.htm

If the EU countries introduce more stringent emission charges and taxes on energy products (and the derived "implicit" carbon taxes), then they impair their comparative price advantages for energy/carbon intensive commodities (i.e., iron ore, steel, mineral fertilisers, petrochemical products, electricity, etc.). Exports of these commodities immediately fall, and soon domestic production will be also reduced. Finally, a re-allocation of resources into de-carbonised (i.e., environmentally benign) sectors will take place and, as a result, environmental quality in these countries will improve.

What kind of structural adjustment will take place in the country like Ukraine that does not pursue (for several reasons) energy and carbon taxation? Obviously, that its comparative price advantages will rise and it will increase the production of energy/carbon intensive (i.e., environmentally adverse) goods. As a result, a re-allocation of domestic resources and additional foreign investments will occur in favour of energy and carbon intensive industries (see table 1 in the previous section). Finally, environmental quality in the country will worsen.

Unfortunately, a few people in the Cabinet of Ministers of Ukraine (including the Ministry for the Environment) do understand that environmental policy of foreign countries, say European Union, can affect environmental quality in Ukraine. This comes about by industrial specialisation and trade. Unconditionally, such policy is fraught with further environmental deterioration due to increase of SO2, NOx and other local emissions.

Social sustainability

►Indicator 3: Households with access to electricity

Vector Value Calculation:

We can consider 99% of Ukrainian population to have access to electricity. This figure hardly changed from 1990 to 1999.

Vector Value:
1990 vector ~ 1-(99/100) **~ 0,01**
1999 vector ~ 1-(99/100) **~ 0,01**

Ukraine has well-developed electricity distribution network which is covering all of the inhabited area. We can consider virtually all households to have access to electricity with minor exceptions.

From the early years of the USSR (which Ukraine was part of until 1991) industrialisation and development of energy system was priority for the government. "Communism is the power of Soviets plus electrification of the whole country" - this formula proposed by the leader of communist revolution became a pithy saying. As other reasons for developed electricity network we can mention high industrial capacity of Ukraine, transit role and extremely small number of the out-of-the-way places.

Length of Arial power lines of the Ukraine Power ministry (1997)

Voltage, kV	ths km
800 (direct current)	0.10
750	4.08
500-400	0.64
330	12.46
220	3.18
154	7.52
110	30.87
35	61.90
20-3	327.58
0.5 and less	467.57

However, electrification can not be consider complete:

- There are settlements where few people (one-three houses) live and which are relatively far from the grid. Number of people living in such conditions is paltry when compared to the total population,

- There are territories in Ukraine declared to be zones of unconditional resettlement due to the high level of radioactive pollution caused by Chernobyl disaster. These territories are cut off the grid. However, some inhabitants refuse to live their hoses and keep living there.

- As a result of difficult economic situation and luck of culture, electrical wires and equipment are stolen every day to be sold as scrap metal. This leads to regular de-energising of areas.

- Finally, for years Ukraine experiences luck of electricity. In this situation energy distributors forced to do rolling blackouts through the regions. Thus, consumers are not able to use electricity despite being technically connected to the grid.

Centralised electricity supply has a role to play in electricity shortages experienced by consumers. There is a lack of energy sources independent from the centralised grid. Potential of the local small energy sources was ignored. In particularly. Ukraine has great potential for small-scale hydro, which was once in used but neglected last decades.

Transport of the electricity through the network in Ukraine lead to 19.97% loose in 2000 (30.9 TWh compared to gross consumption 154.7 TWh[16]). Naturally, these looses are reflected in the electricity price for final consumers.

[16] Energy Today, by the Ministry of Fuel and Power (Olexander Dupak, 31.01.2001)

►Indicator 4: Investments in clean energy

Vector Value Calculation:

1990 fraction = 0.0, and 1998 fraction = 0.038. The length of the unit vector is 0.950 – 0.0 = 0.950. Foreign investments in clean energy as a fraction of total power generation investments in 1998 we equal to 30 / (317+114++20+36+200+91) = 0.038. The growth of investments in clean energy in 1998 represents a new position of the vector: (0.950 – (0.038 – 0.0)) / 0.950 = 0.96.

Vector Value:
The growth of investments in clean energy in **1998** represents a new position of the vector: (0.950 – (0.038 – 0.0)) / 0.950 = **0.96**.
1990 = **1**
1998 = **0.96**

In the FSU investment policy in energy sector has been geared towards supplying energy rather than to DSM or "energy services." In Ukraine, the historical legacy of a centrally planned energy supply remains in the form of perverse incentives to invest in nuclear energy projects.

Table 4.1. Capital investments in Ukraine's fuel and energy sector in 1990, million KBV[1]

Power generation	40
Coal industry	2592
Oil industry	396
Gas industry	1125
Renewables	0

Thus, in 1990 the fraction of "clean" energy investments was equal to 0.

Since 1994 Ukraine has proclaimed an introduction of new energy policies. The proclamations are often very general statements of policy, many of which refer to the importance of energy supply. Few of these policy statements, however, are backed up by specific legislation, obligations or resources. Many of the energy policies adopted and applied to date give little significance to the environmental impact of energy production and consumption, provide disincentives for investments in alternative energy sources and/or energy efficiency projects and set misleading and perverse economic signals. Unfortunately, Ukrainian policy makers tend to underestimate investments in clean energy mainly because of time lags. Very often it takes from 3 to 5 years or more to realise the environmental and economic benefits of clean energy investments, whereas political mandates of policy makers achieve much quicker results.

According to the National Energy Programme of Ukraine, Adopted by the Parliament in 1996, the total amount of investments needed for development of Fuel and Energy Complex had to be 8,631.8 trillion of karbovanets (KBV) [2]. Starting in 1995, these investments (in trillion KBV) had to be distributed in the following way –see table 4.2 next page.

[1] Ukraine: Energy & Economy. EC Energy Sector in Kiev. 1997.

[2] KBV 188,500 = US$ 1 (Feb. 1996).

Table 4.2. Target investments in fuel and energy complex, [19]

	trillion KBV	Fraction
Coal industry	3,380.42	39.3
Oil and gas industry	1,961.50	22.0
Oil refining	266.9	3.0
Power generation	1,557.0	18.0
Nuclear power	376.7	4.4
Alternative and renewable power	145.6	1.7
Machine building industry	76.647	0.9
Other		10.0
Total	8,631.8	100.0

As it follows from this table, the planned investments in clean energy as a fraction of total power generation investments had to be equal to 145.6 / 1,557.0 = 0.093. In the past, Ukraine's investments in "clean energy" never exceeded 0.1% [20]. This year budget foresee 25 m of UAH for energy saving measures in country's economy [21].

The reason for such small fraction is quite obvious. In 1990 more than 45% of the capital stock in power sector appeared to be physically worn out and needed to be replaced. Now situation is much worse, as huge capital investments are needed to maintain main generating capacities on their current level, table 4.3.

Table 4.3. Ukraine capital stock in power sector in 2000.

Number of years in operation	Capacity, GW	Share, %
20-30	16.6	51.6
30-40	15.1	46.9
Over 40	0.5	1.5

Presently there is a growing tendency of dramatic investment reduction in Ukrainian power sector. During the last 5-7 years the Government was highly constrained as a source of capital. The state owned utilities have sold energy at prices substantially below the cost of production and cannot internally finance major new investments, even if these have attractive paybacks. One of the main barriers to energy efficiency investments in Ukraine is the risk that large industrial enterprises for whom energy efficiency would be extremely cost effective will not survive the overall privatisation and/or restructuring of the Ukraine economy.

This tendency of reducing investments into power generation, when taking into account the fact that main assets are becoming obsolete and worn out, can lead to the uncompensated withdrawal of a considerable part of its generating capacities, and their rehabilitation will require much more time and investments. Since Ukraine has built up huge debts importing gas from Russia and Turkmenistan, it has no money to invest in modernisation of energy infrastructure or "clean" generating capacities. As we mentioned above, a small amount of available money is used for nuclear reactors. Thus, Western help seems to be the only way out.

In accordance to these circumstances, the World Bank and other donors started their financial assistance with the rehabilitation of power generation, transmission and distribution. With the Electricity Market Development Project ($317 million), the WB is supporting the restructuring, and rehabilitation of power sector enterprises, helping them

[19] National Energy Programme of Ukraine, 1996.

[20] Serhi Bevz, Head of the Directorate of the State Committee on Energy Conservation of Ukraine. Personal Communication, February 2001.

[21] UAH 5.43 = US$1.0 (Feb. 2001).

to improve cost recovery, financial self-sufficiency and payment discipline. To improve the quality of power supply, the WB is financing the rehabilitation of hydropower plants through the ongoing operation ($114 million).
Besides that, the World Bank and the EBRD are involved in financing projects to rehabilitate district heating systems in Lviv and Dnipropetrovsk (respectively USD 20 and 36 m). In Kyiv, the WB and EBRD are jointly financing modernisation of heat supply and distribution facilities of Kyivenergo (respectively $200 and $91 million).

We will consider all these projects as energy investments with some environmental dimension. At the same time we can classify the EBRD $30 m loan for UkrESCO as investment in clean energy. If so, than foreign investments in clean energy as a fraction of total power generation investments in 1998 we equal to

$$30 / (317+114++20+36+200+91) = 0.038.$$

Economic sustainability

►Indicator 5: Energy Resilience

Vector Value Calculation:
1990 Total Consumption is 9,961.4 PJ, while import 5,350.5 PJ.
1995 Total Consumption is 6,878.1 PJ, while import 3,130.8 PJ.

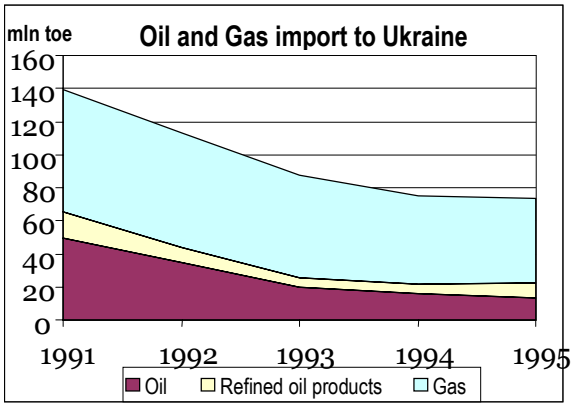
Vector Value
1990: 5,350.5/8,987.6=**0.60**
1995: 3,130.8/6,193.4=**0.51**

Ukraine is import dependent country in terms of energy. Since Ukraine got independence in 1991 the question of energy independence was one of the primary issues of state security. Main source of energy import for Ukraine is Russia. Even when Ukraine buys fuel from the third parties (for example gas from Turkmenistan and oil from Kazakhstan) it is still transported through Russia. In 1995, 20.3% of coal, 72.4% of natural gas and 77.5% of crude oil consumed in Ukraine was imported [22].

Ukraine plays important role as a transit country for Russian oil and gas to Europe. Through the pipelines installed by the Soviet Union to support Central Europe Ukraine transported 123.6 bln cbm of gas and 56,5 m tones of oil transit in 2000.

Surprisingly, high dependence on energy imports does not lead to improvements in energy use efficiency. Ukraine energy use says extremely highly. This is caused by non-payment and reliance on energy extensive exporting industries as metallurgy.

For the period 1990-1995 Ukraine experienced sharp decrease of oil and gas import as a result of overall economic decline illustrated by the diagram 'Oil and Gas import to Ukraine'[23]. In 2000 the country imported 5,8 m tons of oil, 2 m tones of coal and 60,7 bln cbm of gas.



None of the imported to Ukraine energy can be considered sustainable. The country imports coal, oil and gas, and not electricity. Ukraine can technically import energy from Russia where share of renewable energy is paltry.

Decline in energy import is not the result of increased domestic production. It is solely the result of fallen demand due to the economic crisis. Domestic energy production was not falling as fast as demand and energy import was the first source to skip. As a result, relative value of energy import has decrease. However, decline of energy import to Ukraine did not decrease dependence on donor countries (first of all Russia).

[22] Business guide to the energy sector of Ukraine. Tacis. May 1997.

[23] Energy Policy of Ukraine.OECD.1996.

Table 5.1. Energy import and consumption in Ukraine[24].

				Hydro as renewable	
		1990	*1995*	*1990*	*1995*
Import	mtce	211.4	123.7		
	PJ	5,350.5	3,130.8		
Total consumption	Energy and Electricity mtce	355.1	111.1		
	Energy and Electricity TWh	270.5	190.2		
	PJ	9,961.4	6,878.1	9,922.9	6,841.4

Total *non-renewable energy consumption* is virtually equal to total *energy consumption*. Total renewable energy import is at zero level.

Counting big hydro as renewable does not influence the indicator value.
Hydro energy production 10.7 TWh (38.5 PJ) in 1990 and 10.2 TWh (36.7 PJ) in 1995.

[24] Business Guide to the energy sector of Ukraine. Tacis. May 1997.

►Indicator 6: Burden of energy investments

Vector Value Calculation:
According to the Cabinet of Ministers n 1999 GDP was UAH 127.1 bln (USD 32.37 bln). Counting in Chernobyl-related expenditures we have UAH 4.9 bln or USD 1.25 bln of energy-related investments.
There is no data for the year 1990 available. Ukraine was still a part of the Soviet Union. However, we can expect that relative investments where about the same or slightly higher.

Vector Value
1990 ~ **0.4**.
1999 = (1.25/32.37)* 10 = **0.38**

In 1990 Ukraine was still part of the Soviet Union. Socialist system implies capital goods to be state property. Thus, any investments made in energy sector were done from the state budget. The situation is similar today. Despite the declared need for energy sector reforms and privatisation, not much have been done.

State controls energy sector and energy utilities, subsidies them and force them to deliver electricity to consumers, who are not able to pay the bills. Thus, general public finally pays for inefficient use of energy by consumers stealing energy or not paying for it. Year 2001 is expected to be the start for privatisation in energy sector. The government plans to sell a number of distribution companies. However, this process is constantly being delayed.

In nineties Ukrainian government investment in energy sector (including capital investments, maintenance and research) have fallen done dramatically. Ministry of Fuel and Energy was requesting UAH 1,300 m to be allocated in state budget for the year 2000. The ministry announced that it did not receive the entire amount, but had UAH 2,699.9 m of capital investments[25].

In the 2000 budget UAH 1.5 bln was allocated to cover the backlog for energy use of state institution of all levels.

Ukraine is a country where investments to mitigate impacts of the unsustainable energy use was especially high. Today, 15 years after the disaster at Chernobyl nuclear power plant, Ukraine keeps paying to recover. For about ten years 14% of annual state income was directed to deal with consequences of the disaster. Ukrainian state budget has a section devoted to social consequences of the Chernobyl catastrophe and impacts mitigation which in 1999 counted UAH 1.75 bln. Same year budget allocated UAH 30 m for maintenance of Chernobyl reactors out of operation.

Overall state budget for 1999 counted for UAH 25.13 bln. In 1999 sate budget 1.6 bln hryvnas was allocated for energy and fuel industry, UAH 421 m for the coal sector restructuring, UAH 1.1 bln for the state support of coal mining. Thus, energy related investments counted for UAH 3.1 bln without Chernobyl related expenditures and UAH 4.9 bln with it (19% of the annual budget).

[25] Energy Today, by the Ministry of Fuel and Power (Olexander Dupak, 31.01.2001)

Technological sustainability

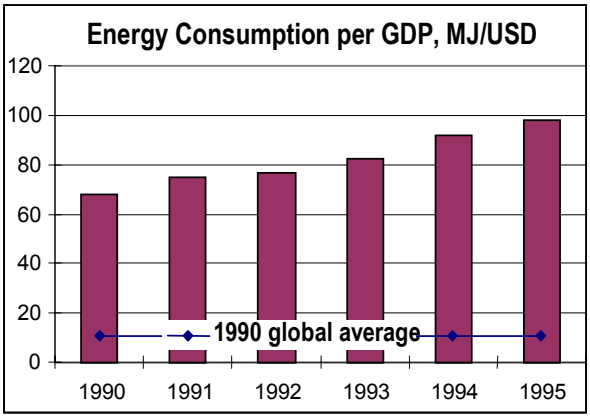
►Indicator 7: Energy Productivity

Vector Value Calculation:
Ukraine energy consumption per $GDP was 67.97 in 1990 and 97.95 in 1995.

Vector Value:
1990 = (67.97-1.06)/9.58 = **6.98**
1995 = (97.95-1.06)/9.58 = **10.12**

Ukraine is highly inefficient country in terms of energy use. The situation dates back to Soviet time. Planning economy of the USSR implied progress to be expressed in the number of products produced no matter what quality it is and whether it is needed. On another hand, there was no economic incentive to reduce production costs, use of raw materials and energy.

In nineties, production in Ukraine was falling down sharply. Energy use however did not go down as fast. In 1990 - 1995 GDP has reduced by 55%, final energy use dropped by 42% from 184 m toe in 1990 to 106 m toe in 1995. Thus energy intensity increased dramatically.



The main reasons identified are: (i) the economic structure, with its emphasis on energy-intensive heavy industry; (ii) use of older, inefficient technologies given low historic energy prices; (iii) the use of electricity in industry which is high compared with the OECD; (iv) poor insulation standards in most buildings; (v) low appliance efficiencies; and (vi) energy management practices, metering and recording systems which are non-existent or poor. Other than low energy prices until recently, perhaps the major reason for the higher energy intensity is the capital stock created under the era of central planning. The industrial capital stock was geared heavily to the production of heavy industrial outputs such as steel and basic chemicals, and military hardware. Both its structure, and the technology embodied within it, reflected then-contemporary prices, costs and investment criteria which were very different from those of the OECD economies.

Another explanation for increasing energy use per GDP is under-recording. A lot of business in Ukraine is not done officially to avoid taxes. Such activities are not reflected by GDP, while still consume energy accounted. If GDP data are corrected to reflect under-recording (perhaps of some 30-50 per cent), the energy intensity of the economy is lower, but still very much higher than in the OECD countries.

Ukrainian government has declared the improvement of Energy Efficiency to be a priority of the energy sector development. However, the energy saving program is hardly implemented. Instead, the President of Ukraine is pushing forward completion of the nuclear reactors. Completion of the new facilities looks ungrounded in a view of unused installed capacities.

Table 7.1. Changes of energy use and economic development of Ukraine in 1990-1995 [26]

	1990	*1991*	*1992*	*1993*	*1994*	*1995*
Total Consumption, m toe	252.63	250.57	219.91	193.66	165.13	160.95
Total Consumption, PJ	10,577.62	10,491.37	9,207.63	8,108.54	6,913.99	6,738.98
Population m	51.9	52	52.1	52.1	52	51.9
GDP bln USD	155.62	140.03	120.44	98.18	75.6	68.8
Energy Consumption per GDP, MJ/ USD	67.97	74.92	76.45	82.59	91.45	97.95
Total Consumption per capita, PJ per person	203.81	201.76	176.73	155.63	132.96	129.85

To improve the energy efficiency in Ukraine few things have to be done:

- Privatisation of the energy facilities in a way that they can compete for customers.
- Development of the energy market. Only about 25% of energy (electricity and heat) delivered to final consumers is paid in cash. A lot of deliveries are paid with barter or not paid at all.
- Deregulate energy prices. Although, energy price was rising over last years it is still seen to be too low. Incentive to invest in energy saving is needed.
- There must be strong political commitment of the authorities at all levels to facilitate energy efficiency programs.

In the year 2000 Ukraine consumed 122849.1 GWh of electricity, 60.367 m ton of coal, 8.4889 m ton of oil and 73.4 bln cubic meters of natural gas. This figures lead to 4894,53 PJ. Same year GDP stands for UAH 175 bln USD 28 bln. Thus, energy intensity stands at 175 MJ/USD. This figure is not reliable since it double count coal use (as coal and as electricity produced out of it). However, it demonstrates trend for decreasing energy productivity. Vector value for 2000 would be about 18.

[26] Energy Policy of Ukraine.OECD.1996. Based on World Bank Data

►Indicator 8: Renewable Energy Deployment

Vector Value Calculation:

Seeing that in 1990 a share of "renewables" within the capital investments in Ukraine's fuel and energy sector was equal to zero (see table 4.1), we can assume that the use of renewable energy was equal to zero as well. Therefore, in 1990 the renewable energy fraction was simply 0. (0.95 -0)/0.8636=1,10004

As it follows from table 8.1, in 1999 the situation with renewables was slightly better: 0.08%. Target value is 95% of energy consumed to be renewable. So, we can assume that Ukraine's vector value for 1999 equals (0.95 – 0.0008)/0.8636 = 1.0407

Vector Value:
1990 ~ 1,100
1999 = 1,099

Of the renewable energy sources, only hydro power makes a significant contribution to Ukraine's electricity supply at present. About 8.7% of total installed capacity is accounted for by hydro plants, but this generates 14.3 bln kWh or about 8% of the country' electricity, table 8.1. Part of the reason for this low utilisation factor is the fact that most of the major hydro stations are located on the Dnipro River, on which the flow is highly seasonable. However, some of the hydro plant is used at least partly to provide much-needed peaking capacity, to maintain system stability.

In accordance with the National Energy Programme of Ukraine [27], in 2000 the share of renewables in Ukraine's net generation of electricity had to be 0.8% or 2.1 bln kWh. Because of severe budget constrains during the previous five years, this programme has not been fulfilled. Actually, less than 10% of needed funds have been assigned for renewable energy in 1996-2000. Therefore, we can consider that in 1999 the real share of renewables was around 0.08% [28].

Table 8.1. Ukraine's net generation of electricity in 1999 [29]

	bln kWh	%
Fossil fuel	86	49.9
Nuclear electric	72.1	41.8
Hydro electric	14.27	8.22
Renewable electric	0.13	0.08
Total	172.5	100

Besides that Ukraine possesses significant resources of wind, solar, small hydro, biomass and geothermal energy. Although none of these are currently exploited in significant quantities for electricity generation, their potential future contribution to the energy balance is being explored [30].

[27] National Energy Programme of Ukraine. Adopted by the Rada (Parliament) in May 1996.

[28] Borys Korobko, Director of the State Research Institute of Non-Traditional Energy Sources. Personal Communication, January 2001.

[29] Ukraine Power Industry. Ministry of Fuel and Energy of Ukraine. Kyiv, 2000.

[30] Comprehensive State Energy Conservation Programme of Ukraine. Kyiv, 1996.

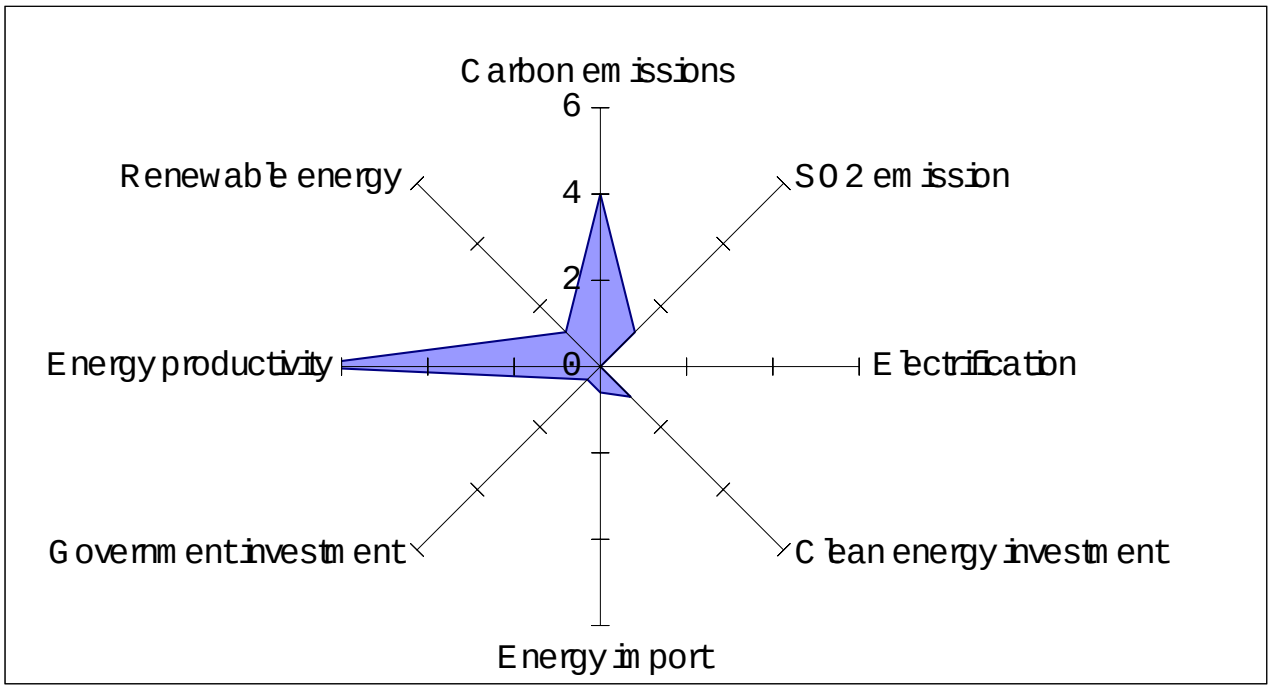
First Ukrainian wind mills were installed in 1993. Since that time existing wind mills (table 8.2) produced around 17.5 m kWh of electricity [31]. It should be mentioned that the larger half of installed turbines are outdated USW 56 -100 type.

Table 8.2 Installed wind mills (1999).

No:	Location / Name	Number of wind turbines
1.	Donuzlav	53
2.	Novo-Azovsk	27
3.	Saki	21
4.	Truskavets	7
5.	Askania-Nova	3

[31] Borys Korobko, Director of the State Research Institute of Non-Traditional Energy Sources. Personal Communication, January 2001.

Star for Ukraine



Conclusions

On the one hand, there is a wide body of empirical data and research papers outlining the relationship between the state of the environment and energy policy (i.e., initiatives focusing on energy efficiency and renewable sources of energy). Such initiatives include setting minimum efficiency standards for buildings, appliances and lighting, providing grants and other incentives for renewable energy use, running informational campaigns, and setting up effective energy efficiency centres and agencies for implementation. The EU countries have been the most successful in improving the energy efficiency of their economies (e.g. Denmark, Germany and the Netherlands) and have clearly linked the energy and environmental sectors through governmental policies and programs.

On the other hand, prior to 1991, countries of the Former Soviet Union paid only lip-service to the role of energy efficiency in their centrally-planned economies. Low energy prices, extensive subsidies throughout the energy system, and a quota system of energy allocation provided clear disincentives to save energy. High energy intensity levels were viewed as a sign of economic development and progress, hence, high energy use was encouraged. Some of this legacy remains both in cultural attitudes and the inefficient infrastructures still in place today.

In Ukraine, linkages between energy and the environment are evident in all phases of energy production, transformation, and end-use. They extend from highly localized effects (at the level of the household) to the global level. On the local level, the most serious energy-environment problems are the effects of emission of particulate matter (dust and smoke), SO_2 and indoor air pollution arising from the use of coal (in the rural areas) and leaded gasoline (in the urban areas). These and other local level problems lead to increased levels of greenhouse gases in the atmosphere which contribute to the severe regional and transitional problems of acid rain, stratospheric ozone depletion, and the degradation of oceans. Domestic industry, transport, and energy use are prime sources of these environmental problems, which impose serious costs on health and productivity in Ukraine.

Since 1994, Ukraine has proclaimed its introduction of new energy policies. The proclamations are often very general statements of policy, many of which refer to the importance of energy supply. Few of these policy statements, however, are backed up by specific legislation, obligations or resources. Many of the energy policies adopted and applied to date give little significance to energy-environment interactions, provide disincentives for energy efficiency project investment and set misleading and perverse economic signals. Unfortunately, Ukrainian policy makers tend to underestimate the combined energy-environment approach mainly due to time lags. Very often it takes 3 to 5 years or more to realise the environmental and/or economic benefits of such an approach, whereas expiry dates of policy makers' political mandates are much shorter.

The consequences of such circumstances have far reaching implications. Energy efficiency places very low among the priorities on the government's overall policy agenda. Inappropriate energy demand forecasts have been keeping economically marginal power plants and coal mines open. As a result, energy policy is still focusing on construction and/or rehabilitation of unnecessary capacities.[32] Many inexpensive efficiency projects are delayed due to a lack of project management and technical expertise. Energy policies which give a low priority to efficiency compared to energy supply encourage utilities and consumers to waste energy. Pollution externalities are not factored into energy pricing, hence subsidising more polluting energy investments.

[32] Economic Assessment of the Khmelnitsky 2 and Rovno 4 Nuclear Reactors in Ukraine. Report of the EBRD, the EC and the USAID by an International Panel of Experts chaired by Professor John Surrey. Science Policy Research Unit, University of Sussex, 4 February 1997.

Present reliance on heavy industry and older energy intensive technologies (the latter owing to insufficient investment to allow upgrading of capital stock over the last several years) is a major cause of industrial pollution in Ukraine. Industrial plants are also characterised by their vast production scale, even by global standards, which contributes to energy intensity and other resource pressures. Poor housekeeping and maintenance have further aggravated pollution and safety problems.

Another argument commonly used against the energy-environment approach, also used in Western countries, is that the entrepreneurs loose competitiveness when all the external costs of energy production are internalised. However, even in the EU countries there is a range of market imperfections, which significantly inhibit the implementation of cost-effective efficiency opportunities. These imperfections are even more formidable in countries like Ukraine where prices may be below the actual cost of energy supply (at least in some Ukrainian sectors). If the imperfections can be overcome, there are large and highly cost-effective energy savings to be exploited at below the cost of the energy saving measures. In effect, these investments deliver CO_2 abatement at negative cost – the investment is more than paid for by the energy savings.

This suggests that energy and environmental policies should work toward common ends, and trade-offs only begin to arise at the margins of policy making. Ukraine clearly needs more time and research to show how appropriate economic incentives in the economy at large, and the use of specific economic instruments targeted at local air quality and emissions, can make an important practical contribution towards mitigating the adverse environmental effects of energy supply and use.

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