Mr. Svoboda, Mr. Buzek, Mr. Cramer,
Ladies and Gentlemen of the Committee,

Thank you very much for the invitation to be here today to be part of this important discussion on what to do about summer time. You've heard about traffic, tourism and economy, and in the coming 10 minutes, I will try to tell you how scientists view Daylight Saving Time.

My name is Martha Merrow. I am a professor in the Department of Medical Psychology at the Ludwig-Maximilians-University in Munich. My research concerns the circadian clock and I'm here not representing my work so much as that of my field, chronobiology. That said, much of the impetus for our scientific discussions on this topic comes from the work of my colleague Till Roenneberg, who is also from the Medical Psychology Department in Munich.

To get you into this material quickly, I'm going to ask you to stop and reflect for a moment on those with whom you live – specifically, when they sleep in relation to when you sleep.

Most of you will recognise that the others in your household are sleeping either earlier or later than you are. The teenagers in your house are much later than you. The younger children are much earlier. Importantly, even amongst the adults, everyone has a unique preference for a certain time window in which to sleep.

And I guess that – when you think about it – you would concede that this preference is not a preference in the traditional definition of the word. You don't choose your sleep timing, or your chronotype, because it's controlled by your biological clock and your biological clock is programmed in your genes. That's point number one.

Point number two is that the timing of sleep is just the tip of the iceberg. Biological clocks control our life at many levels ranging from gene-activation and hormonal regulation to behaviour, cognition and performance – their task is to optimise metabolism, cardiovascular, immune and other systems by making sure that they occur or function best at a certain time of day.

A third concept is that the circadian clock is actively taking signals from the environment in the form of light and darkness. Both the timing and the amount of light combine to adjust the timing of our biological clock.

The impact of light on your biological clock is so strong that if you live in the eastern part of a time zone, you will awaken earlier relative to local time because the sun time is earlier. The impact of light on your biological clock is so strong that less light during the day and/or more light during the night makes most of you a later chronotype. The impact of light on your biological clock is so strong that if you expose yourself to more light in the evening than in the morning, most of you will become later chronotypes.

If your chronotype were perfectly suited to your light/dark environment and to the clock that controls your social schedule, then you obviously would need no alarm clock. Unfortunately, the Munich Chronotype Questionnaire database that Professor

Roenneberg has built indicates that 80% of the population is using an alarm clock on workdays. This number is probably so high due to a combination of:

- social schedules - work and school times require that we get up early
- a trend towards light-poor environments - low light makes most people's biological clocks move later in the day
- and daylight saving time - which pushes the social clock another hour earlier.

What happens when we use an alarm clock on workdays? The most common pattern shows that we fall asleep only slightly earlier than on free days but we are woken up substantially earlier – long before the sleep time specified by the biological clock is over. Thus sleep is both shortened and it's sub-optimally timed: we are awake and active when our clock says to sleep. With a reference to the jet lag that you experience when you travel, this condition of earlier and shorter sleep is called social jet lag because it is induced by the social clock – by the need to get to work or to school.

If travel jet lag is kept to an occasional occurrence, there seems to be no serious consequence. But social jetlag is a persistent condition, week in and week out, for years. And there are consequences to this chronic behaviour. Some of these are thought to relate to the shortening of sleep: sleep deprivation leads to poor performance, bad judgement and possibly personality changes such as decreased empathy and social competence. Other consequences of social jet lag likely relate more directly to disruption of the biological clock due to sleeping – or waking and being active - at the wrong time: Social Jet Lag correlates with nicotine addiction, and alcohol and caffeine consumption. Social jet lag is also associated with overweight, metabolic disease, and depression – all major health problems in the 21st century. When we indicate correlations and associations this means that there is a statistically significant increase in the indicated behaviour or pathology that is predicted by the amount of social jet lag. More social jetlag, more overweight.

This is the background information necessary to understand how Daylight Saving Time impacts health. The DST transition in spring effectively advances the social clock by an hour. In the fall, we get that hour back as we push back to normal time. Meanwhile, the impact of light on your biological clock is so strong that the biological clock is set by the actual light and dark of the environment, not by the social clock. So with DST, we just have to go to work an hour earlier, according to our biological clock, and we accumulate more social jet lag.

We note two classes of effects that are associated with DST. The first are acute effects in the form of increased heart attacks and accident rates in the first days after the time change. The second are chronic effects, deduced and predicted from correlations: the transition to summer time means an extra hour of social jet lag and more social jet lag means more cigarettes, more alcohol, more overweight, more type 2 diabetes, more depression. These are some of the modern epidemics and thus contribute substantially to health care costs. One estimate puts the cost of social jet lag – combining projected health care costs and losses in productivity - at 1% of the GNP, in which case it would cost the EU 131 billion Euros per year. Moving away from DST and decreasing social jetlag would obviously decrease this figure.

This probably sounds inflated but I actually think that it's a gross underestimate based on the experience of those most impacted by social jetlag, namely teenagers who

experience the latest chronotypes due to normal, developmental changes. Europe is proud of its academic tradition and recognises the key role that education plays in her future. We recently published a study showing that high school students with later chronotypes, and with higher social jet lag, perform worse on exams given early in the day compared to when they are examined later. We thus are selecting our workforce – those that go to University, those that get directed to skilled labour - partially based on chronotype.

We know that DST increases social jetlag and that chronic social jet lag leads to performance and health deficits. From the scientists' viewpoint, we suggest that you target solutions to this problem including increasing the daylight in our environment – controlling both the timing and amount of light, pushing back work and school times, and abolishing Daylight Saving Time. All these actions will decrease social jetlag in the European population.