Position paper

# European Directive on Discontinuing seasonal changes of time

***"Timing is Everything"***

**Gezondtijd! collaboration**

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## SUMMARY


**Purpose of this paper**

This paper explains the current scientific insights and social consequences of the DST clock changes. Our aim is to make a responsible contribution to the debate so that informed policy decisions can be taken at national and European Union level.

**Motivation**

The EU proposal to abolish clock changes was adopted by the European Parliament on March 26th, 2019. The national governments now have to determine their position after which the European Council must reach a joint decision. In the Netherlands, the Ministry of the Interior and Kingdom Relations (BZK) deliberates on the Dutch choice with national and international consultations. So far, the Dutch government has presumed 3 options: maintaining the clock changes, switching to permanent Central European time (the current standard time), or switching to permanent Eastern European time (the Dutch "summertime").

**Context**

Europe currently has three time zones: the Western, Central and Eastern European time zones. Together with Belgium, Luxembourg, France and Spain, the Netherlands is geographically located in the Western European time zone but has used Central European Time as the standard time since the Second World War. As a result, the position of Western EU is substantially different and demonstrably more disadvantageous than that of the other EU member states.

This position paper makes clear how important it is to live in one's own time zone, with sufficient daylight, sufficient sleep and according to one's own circadian rhythm (chronotype). Unlike the social clock, our biological clock does not change easily. Ground-breaking studies in chronobiology show how our personal biological clock has a fundamental impact on our health, our functioning and our performance.

**Social consequences**

In the current digital 24/7 era, our lives are more than ever before dictated by the social clock. In Western Europe this clock is set to switch twice a year between two non-geographical time zones. It is becoming increasingly clear how harmful this is, both at an individual level and for society as a whole. The negative consequences are very large and lead to creeping expenses that devour billions of euros. The sectors most affected are health, work, education, mobility, safety and the environment.

A single adjustment will be sufficient to greatly reduce many of these harmful effects. An adaptation to the country's own geographical time zone, focused on sufficient daylight at the right times of the day and taking into account the natural diversity of chronotypes.

**Conclusions**

The scientific position is clear:
- Clock changes and "permanent summertime" are unhealthy for citizens, the environment and the economy.
- Recommendation: switch to "permanent standard time" in the country's own time zone.

So far, the Dutch government has presumed 3 options. This paper concurs with the scientific advice to add our own geographical time zone as an option and to prioritize it as the most responsible choice:

1. Permanent Western European Time (WET): the geographical time zone
2. Permanent Central European Time (CET): the current standard time or "wintertime"
3. Maintaining current clock changes: 5 months "wintertime" / CET and 7 months "summertime" / OET
4. Permanent Eastern European Time (OET): the current "summertime" – science advises against this option.

## PURPOSE OF THIS PAPER

This paper explains the current scientific insights into the social consequences of the clock changes and unravels myths and misunderstandings surrounding the topic. It concerns a complex matter with **substantial consequences**, which strongly influence people's daily lives as well as the **society** at large and the **environment**. The government, its knowledge institutes and advisory councils as well as the trade and industry, the civil society and citizens themselves are all still insufficiently aware of this scientifically substantiated impact.

This position paper was drawn up by the Gezondtijd! team to make a responsible contribution to informed policy decisions, both at national and European Union level. Scientific concepts are explained, connections clarified and arguments for healthy choices substantiated.

This EU proposal is an excellent opportunity for the Netherlands and all of Western Europe to **shortly cash in** on all the recently acquired **insights** into the relationship between time, health and the economy.

# PART 1. MOTIVATION

## 1A. EUROPEAN DIRECTIVE ON DISCONTINUING SEASONAL CHANGES OF TIME

**Proposal and procedure**

On March 26th, 2019, the **European Parliament adopted the Commission proposal** to abolish Daylight Saving Time clock changes twice a year: "Discontinuing seasonal changes of time" (415 votes in favour and 192 against). The next step now lies with national governments who have to determine their position, after which the European Council of Ministers must reach a joint decision.

The proposal states that the Member States have until April 1st, 2020 to make their own permanent choice if it is different from maintaining the **current "summertime"** throughout the year (for Western Europe this is the Eastern European Time, see part 2). To clarify, the options are choosing the current standard time ("wintertime"), choosing the current standard time + 1 hour ("summertime") or changing to a **different time zone**. This choice would then be effective from April 1st, 2021. With this new proposal, the EU directive from 2000 which sets the exact dates of transition between summer- and wintertime for all EU countries will expire in 2021.

For the benefit of the proposal a **European electronic voting** was held in 2018, the results of which cannot be called valid. The majority of respondents, more than 80%, were German. Participation in the Netherlands was 0.16%. The majority (56%) opted for "permanent summertime", 36% opted for permanent standard time and 8% had no opinion. In addition to this mainly German voice, we can say that the influence of the clock times is little known in all European countries. Moreover, the situation in Germany and other Central and Eastern European countries **differs substantially** from the situation in the Benelux, France and Spain due to their geographical location in relation to their adopted time zone (see part 2).

Prior to the final vote on the proposal for the EU Directive in the European Parliament, **committee debates** were held on February 20th and March 4th, a **workshop** was held, and **amendments** were submitted. For more information we refer to the EU information package (ref 1-1).

The proposal that is now before the governments and European Council also contains a number of **precautionary measures** to prevent an unregulated "**patchwork"** of time zones. It is proposed, for example, to allow for central coordination and to require Member States to indicate 18 months in advance if they wish to change their national standard time. This is to prevent countries from continuing to apply DST clock changes through the trick of regular seasonal time zone changes. In addition, there is an option to extend the proposal until 2022 should the Member States be unable to reach mutual agreement on the standard times to be used within the EU.

In order to help Member States determine their position, Finland, as President of the European Council, presented an **Impact assessment framework** in December 2019 (ref. 1-9). This contains a good spreadsheet tool that can be used to easily calculate the amount of daylight hours per country for every possible scenario, including the option Western European Time zone for Western Europe. It should be noted that this tool was filled with poorly substantiated and outdated impact information based on a small number of incomplete, primarily German and Swedish sources. However, this can easily be adjusted with the information provided in this paper.

**Scientific advice**

Science emphasizes that setting a **single European time** is an **unhealthy option** for all EU countries. Europe is geographically spread out over four time zones and is therefore too broad to adopt one single clock time.

Currently the EU employs three standard times: Western European, Central European and Eastern European Time. Globally most continents and large countries utilize different time zones within their own borders.

In October 2018, the **European scientific associations** EBRS (European Biological Rhythms Society), ESRS (European Sleep Research Society) and the global umbrella association SRBR (Society for Research on Biological Rhythms) advise in a joint statement to abandon the clock changes and to **switch Europe-wide to standard time zones** (ref 1-2):

> *"we would like to emphasize that the scientific evidence presently available indicate that installing permanent Standard Time is the **best option for public health**"*
>
> *Statement EBRS, ESRS and SRBR, October 2018*

These disciplines **unanimously** support the **urgent advice** to globally move away from changing to and from Daylight Saving Time and to opt for **permanent Standard Time** instead. In June 2019, the SRBR (Society for Research on Biological Rhythms) publishes a scientific position paper: "Why Should We Abolish Daylight Saving Time?" (Ref 1-3) and makes a press kit available for its members (ref 1-4).
A scientific overview article follows on August 7th containing all the chronobiological facts that apply to DST: "Daylight Saving Time and Artificial Time Zones - A Battle Between Biological and Social Times" (ref 1-5).
Current also is this scientific opinion piece from the Sleep Sciences: "Time to Show Leadership on the Daylight Saving Time Debate" (ref. 1-6)

## 1B. STATE OF AFFAIRS IN THE NETHERLANDS

It is noteworthy that whilst in the EU this proposal falls under the responsibility of the European **Transport Council**, in the Netherlands it lies with the **Ministry of the Interior** and Kingdom Relations (BZK). This ministry thus has the coordinating role towards the EU regarding the handling of the proposal (ref 1-7). In actual practice most of the other ministries are also directly or indirectly involved in this matter, as evidenced by the expert sessions held by BZK.

The Dutch government is currently considering the following **3 three options**:
a - Maintaining current clock changes: 7 months "summertime" / OET and 5 months "wintertime" / MET
b - Permanent Central European Time (MET): the current standard time or "wintertime"
c - Permanent Eastern European Time (OET): the "summertime"

So far, the handling has been as follows:

- October 12th, 2018: a **group of experts** is asked on short notice by BZK to comment on the EU proposal with respect to content (ref. 1-7). The **advice** of the **chronobiologists** present is to add our own geographical time zone as option 1. According to science, this "solar time" is the most natural and healthy option.
  The experts prefer the following ranking of options:
  1. Permanent **Western European Time** (WET): our own geographical time zone
  2. Permanent Central European Time (MET): the current standard time or "wintertime"
  3. Maintaining current clock changes: 5 months "wintertime" / MET + 7 months "summertime" / OET
  4. Permanent Eastern European Time (OET): the current "summertime"

- The Royal Dutch Academy of Arts and Sciences (KNAW) indicates that the minister must have a **wider range of disciplines** and perspectives for scientific substantiation. In the following months, a number of

**sessions** are held in the areas of Environment, ICT, Financial and economic consequences, Transport and Road safety.

- On the 29th and 30th of October 2018, the Transport Ministers in Graz have an **informal meeting** on the proposal. The Dutch minister is not present.

- December 4th, 2018: debate of the BZK **standing parliamentary committee** and response to the questions submitted to the minister.

- December 17th, 2018: "**Opinions about time systems**, a survey among the general Dutch public and organizations", conducted by Motivaction on behalf of BZK:
  - **Public survey**
    The public survey (flash survey) shows that "always standard time" receives more support than "always summertime" or "half-yearly changing of the clock". The proponents see standard time as better for the biological and sleep rhythm. A spontaneously mentioned reason for this positive attitude is that “wintertime” is the original time and that it matches our time zone.
  - **Business survey**
    The telephone survey among companies and (special interest) organisations shows that most spokespersons do not yet see the problem. They are not looking for change and the subject is not yet on their agenda. The internationally operating sectors are not in favour of every country using their own time. Comments on this survey:
    - ⇒ It is evident that the energy sector is taking an outdated position; there is a clear advantage to spreading energy peaks across different time zones.
    - ⇒ It is contradictory that the transport and financial sectors consider the one-off adjustment to a new time zone to be a problem, but not the recurring biannual switching.
    - ⇒ In the conversation with the **IT** sector, the well-known DST programming **problem** did not arise. Days of 23 and 25 hours and “smart tuning” (= programming) of devices cost extra time and money and provide a greater error risk in all kinds of sectors from energy and telecom to transport and finance.

- March 5th, 2019: the minister's answers have been determined. In the relevant parliamentary document, **the minister's plans** to arrive at a careful, comprehensive assessment are described as follows:
  - ✓ Collect all relevant information
  - ✓ Additional multidisciplinary research for factual substantiation
  - ✓ Inquire about the views of neighbouring countries, including informal consultations in spring of 2019

- On October 15th, 2019, the **RIVM** (National Institute for Public Health and the Environment) publishes its **report** "Standard time, daylight saving time and health" (ref. 1-8) and the minister releases a **Chamber letter** detailing the state of affairs (ref. 1-7). The orientation at the Ministry of BZK is still ongoing and there is no decision as of yet.

  "Breaking news" is the RIVM conclusion:

  *“The current time system of changing twice a year between standard time (UTC+1) and daylight saving time (UTC+2) is accompanied by acute sleep disturbances and health effects, of which the increase in heart attacks during the spring change is the most obvious. These identified acute effects disappear when choosing a permanent time setting. With such a decision,* ***permanent standard time (UTC+1)*** *has a* ***clear preference*** *from a* ***health perspective*** *over permanent summertime (UTC+2), and it is even worth* ***considering*** *setting Greenwich Mean Time* ***(UTC+0) for the Netherlands****."*

# PART 2. CONTEXT

## 2A. ORIGIN OF TIME ZONES AND STANDARD TIMES

**Longitude**
Our planet rotates on its axis in 24 hours and moves slightly tilted in an elliptical orbit around the sun. As a result, we have a day and a night every 24 hours and different seasons in a year. The sun "rises" in the East and "sets" in the West because the earth turns towards the east. The **time of day** is therefore **determined by longitude**. In Eastern European countries the day starts earlier than in Western European countries.

**Latitude**
On the equator there is 12 hours of daylight and 12 hours of darkness all year round. As we move towards the north or south pole, the day and night length become more extreme: longer days and shorter nights in summer, shorter days and longer nights in winter. **Day and night length** are therefore **determined by latitude**. Northern European countries have longer days in summer and shorter days in winter than Southern European countries.

**Local time / solar time**
Historically, local time is used everywhere on earth. The middle of the day (noon) is when the sun is at its highest in the sky, **halfway** between sunrise and sunset. A sundial always indicates the correct solar time and so each location has its **own time**. People do not travel much and when they do, they travel slowly. With the arrival of accurate timepieces, local time becomes an average clock time per village or city. If you don't have a clock or watch yourself, you look to the tower clock to know the local time of the city you are in.

**Industrial artificial time**
With the advent of the industrial age and its faster forms of transport and telecommunications, there is a need for regional **time conventions**. Many countries develop national times for the benefit of industry. The Netherlands only does this for telephony & rail. The rest of Dutch society still uses the local sun times per city or village.

**Time zones**
In 1884 it was proposed to divide the world into 24 practical time zones of one hour each, with Greenwich right next to London as the central point: Greenwich Mean Time (GMT). This way one can easily calculate what time it is elsewhere on the planet (360/24 = 15 degrees per time zone). The clock time within each time zone is called the standard time of that time zone. On the central longitudinal line of every time zone (the **meridian**) the sun is at its **highest point** at **12.00** noon standard time.

This time zone format is not applied immediately. Many countries maintain their own national time and do not switch to time zones until the turn of the century: Belgium in 1892, Germany in 1893, Spain in 1900 and France in 1911 (calling it "PMT-0:09" or "nine minutes difference with Paris Mean Time" instead of GMT). The Netherlands does not switch to GMT and instead introduces its own national time for the first time in **1908**: the **Amsterdam Time** already in use for rail and telephony (GMT+0:19).

The Netherlands holds on to this national time (from 1937 onward as GMT+0:20) until May **1940**, when the occupier aligns our clocks with the German-Polish time. Belgium, Luxembourg, France and Spain are also set to **German time** in 1940. To date, this **Central European Time** is still the standard time in Western Europe, while it is actually a time zone too eastern for our location.

**UTC**

Time zones are nowadays defined using **Coordinated Universal Time** or UTC (a compromise between the English term and the French "Temps Universel Coordonné"). This 1961 worldwide time standard is based on an atomic clock and coordinated with the rotation of the earth. UTC is used in shipping and aviation, weather services, IT and increasingly in legislation and is almost identical to the more well-known **GMT**.

**European time zones**

Europe is so wide that the EU countries cover four geographical time zones and therefore four hours of solar time difference:

| | | | |
|---|---|---|---|
| Eastern European Time | UTC+2 | → | meridian through Kiev |
| Central European Time | UTC+1 | → | meridian through Prague |
| Western European Time | UTC | → | meridian through London and Alicante |
| Azores Time | UTC-1 | → | meridian through Las Palmas |

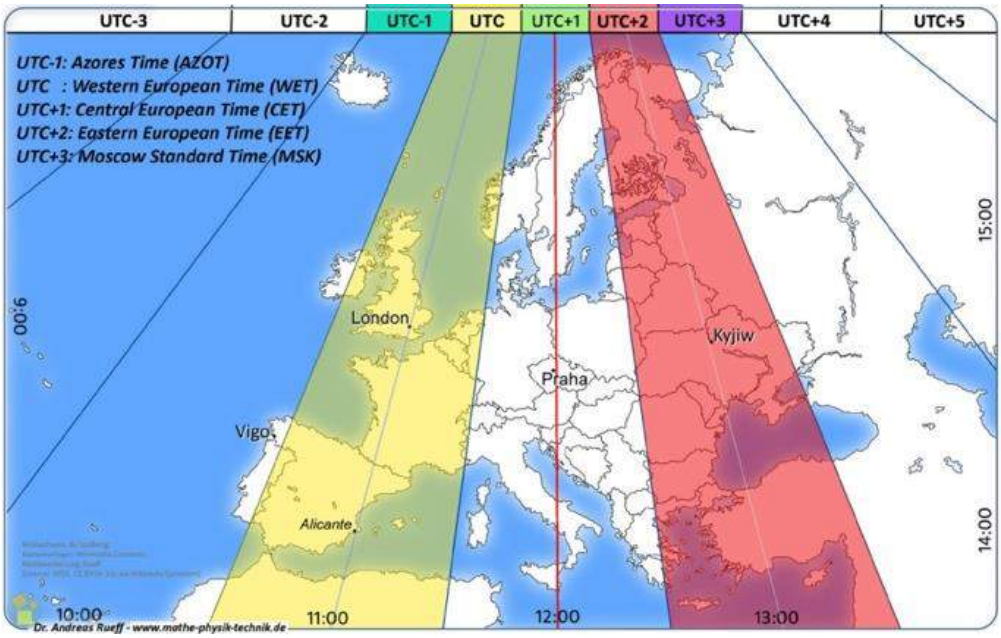



*Figure 1. The geographical time zones within the European Union. The West European Time zone with meridian London in yellow, in red the Eastern European Time zone with meridian Kiev.*

**Dutch time zone**

Together with Belgium, Luxembourg, France, Spain and the United Kingdom, the Netherlands is located in the **Western European Time zone** (see Figure 1).

However, the **Benelux**, **France** and **Spain** still use **Central European clock** time, as a result of which these countries already **deviate one hour** from their geographical time zone during their standard time (see Figure 2). We explain why this is **disadvantageous** in parts 2 and 3 of this paper.

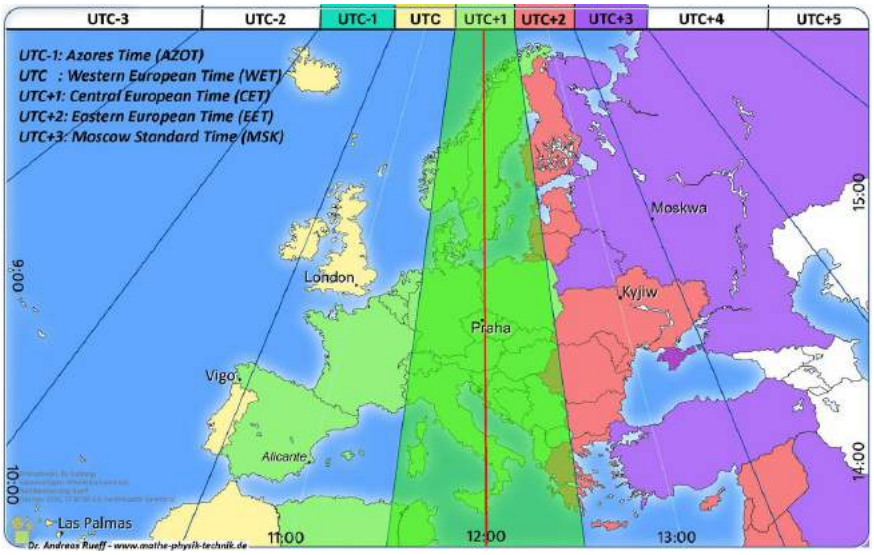



*Figure 2. The current time zone arrangement. The Benelux, France and Spain use the Central European Time (in green).*

As can be seen in Figure 2, most of the **Eastern** European and **Central** European **member states** use their **own geographical time zone**. Russia and Turkey do not. Greece falls into two time zones and has opted for Eastern European Time.

Only the **Western** European member states use a time zone that is **too eastern** for their geography, namely the Central European Time zone. The same applies to Ireland, Portugal and the Canary Islands (and Iceland) which are geographically located in the Azores Time Zone but use the Western European time instead.

The scientific advice is to follow the geographical time zone lines, see Figure 3. We explain why this is better for the inhabitants and the economy in parts 2 and 3 of this paper.

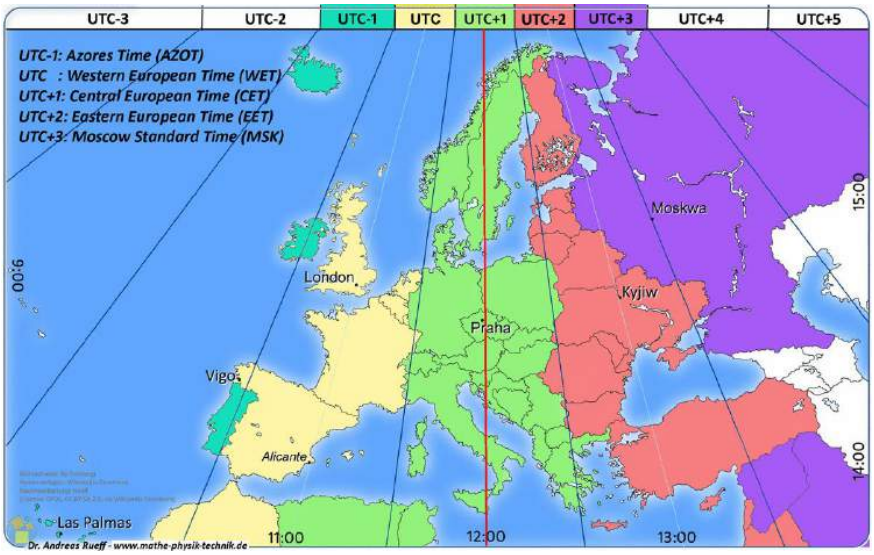



*Figure 3: The ideal time zone arrangement within the European Union:*
*Eastern European Time for Eastern Europe, Central European Time for Central Europe,*
*Western European Time for Western Europe and Azores - Time for Ireland, Portugal, Canary Islands (and Iceland)*

## 2B. ORIGIN OF BI-ANNUAL CLOCK CHANGES / DST

The introduction of the DST or Daylight Saving Time measure as "summertime" in the Netherlands, Germany and Great Britain (and in Belgium as "summer hour") means that the standard time is also called "wintertime". Over the years, this has led to unjustified positive associations of "summertime" with the "summer feeling" and negative associations of "wintertime" with the "winter feeling".

**1916: First World War (WWI)**
The German Empire introduces the term "Sommerzeit" for the first time in 1916: on April 30th in Germany, Belgium and France and on May 1st in the Netherlands. The clock was advanced by one hour for 6 months to save fuel. Immediately after the war in 1918, Germany, France and Belgium abandoned this practice. Spain on the other hand introduces DST for the first time and has since abolished and reintroduced it several times. The Netherlands decides to keep DST in 1918 and switches to **Amsterdam summertime** (**GMT+1: 19**) every six months. This deviates only 19 minutes from the current "wintertime" and is therefore **not the same** "summertime" as the one Netherland currently practices.

**1940: Second World War (WWII)**
In May 1940 the occupying forces set the Amsterdam clock to **Berlin summertime** (GMT+2) and leave it there for two years. Up to and including the summer of 1942, the Netherlands lives under continuous **Eastern European Time**. This is the only period that our country has known "**permanent summertime**" - and even during wartime they decided to go back on that decision after only two years. Half-yearly DST is gradually abolished everywhere after the war, including in the Netherlands. In addition, the Netherlands decides not to go back to the **Amsterdam Time** but to temporarily maintain the Central European standard time (GMT+1). In 1958 this **Central European Time** officially becomes the standard time of our country.

**1977: DST or 6 months "summertime"**
With the oil crisis of the 1970s, Daylight Saving Time comes back. Spain introduces it in 1974, France in 1976 and the other European countries follow soon. The reasons for the introduction in Belgium and Netherlands in 1977 are, in addition to the aforementioned energy saving, the promotion of tourism and recreation. Concretely, this means that Western Europe now lives six months a year on **Eastern European Time** (fig. 4).

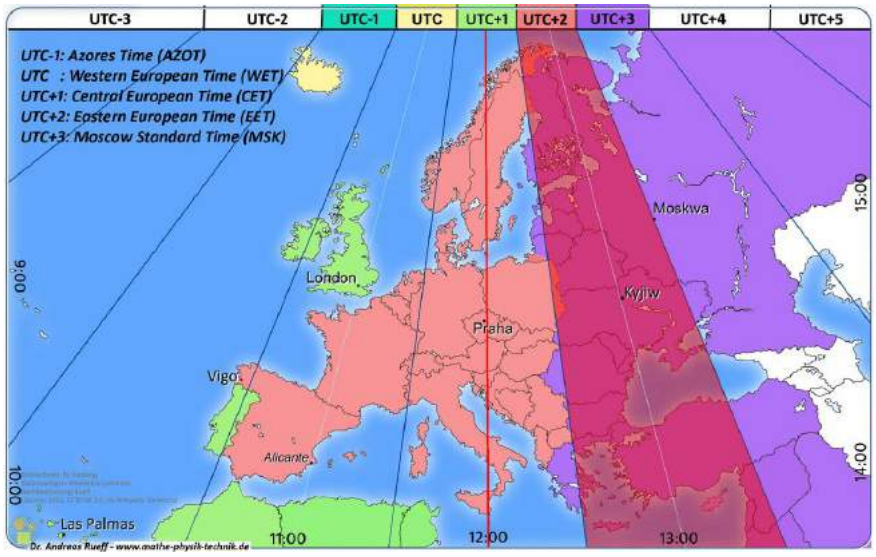



*Figure 4. The current time zone arrangement within the European Union, with DST / "summertime".*
*All of Central Europe plus the Benelux, France and Spain use Eastern European Time (in red) during DST.*

**1980-2000: EU directives**

In 1980 the precise moments of changing to and from DST were laid down EU-wide in a Directive 80/737/EEC. This obliges all Member States to change their clocks at the same times of the year. This guideline is valid for a number of years and is followed by other long-term guidelines. In 2000, Directive 2000/84/EC defined the clock changing times for an indefinite period. This is the directive that the EU now wants to repeal, with some reservations (see part 1a)

**1996: DST standardization or 7 months "summertime"**

Almost twenty years after the introduction of the half-yearly clock changes, an extra month of DST is added in 1996 as part of European standardization. We now all have not six but seven months "summertime" and five months "wintertime" per year. As a result, we can no longer call it a "half-yearly" change; the clocks now change twice a year or bi-annually.

By this time the EU consists of **15 Member States** located in Azores, Western and Central Europe. Since then, **13 more** countries have entered the EU, many of them located in Eastern Europe. This is an additional argument for the Member States to definitively choose their **own geographical time zone** (see figure 3).

**The exceptional situation in Western Europe**

As can be seen in figures 2 and 4, the Western European countries of the Netherlands, Belgium, Luxembourg, France and Spain have not been living in their own West-European time zone for almost 75 years. In the following chapters we explain why these countries are **disadvantaged** by this both in **health** and in **socio-economic** terms.

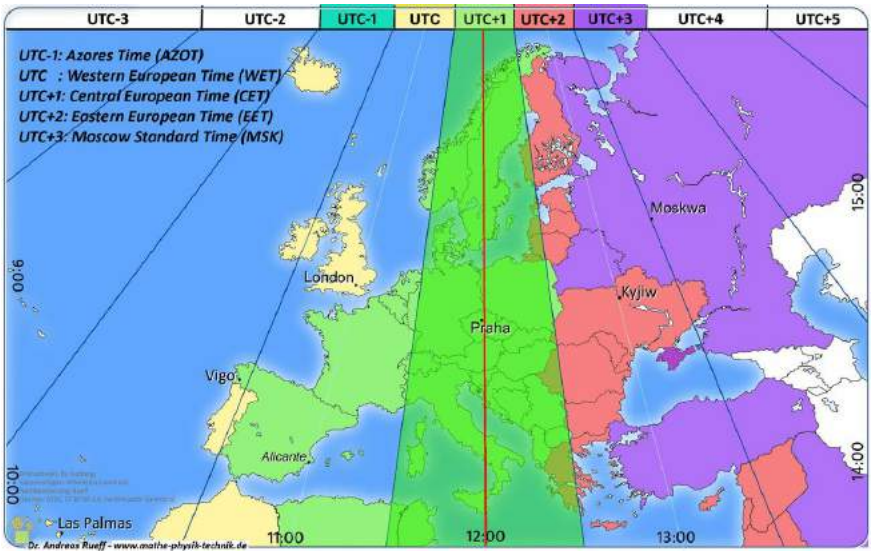



*Figure 2. The current time zone arrangement.*
*The Benelux, France and Spain use the Central European Time (in green).*

## 2C. BIOLOGICAL CLOCK AND RHYTHMS

In essence, this paper revolves around the importance of living according to your own biological clock, including getting a sufficient amount of good sleep. The human body is subject to a 24-hour rhythm that is generated internally. Light, darkness and temperature influence our personal biological rhythm, which is deeply rooted in our genes and which directs the rhythm of all our bodily functions. Things like clock changes, wrong time zones, insufficient light and unhealthy work and school hours all run counter to this biological reality.

**Chronobiology and Nobel Prize**

"Chronos" stands for time. Chronobiology studies the biological rhythms of the body: the biological clock and the influence of day-night rhythms and seasonal changes on living things. These rhythms prove so **crucial** for all life on earth that chronobiology is now called "**the next quantum leap**" for many other scientific disciplines.

In 2017, three American chronobiologists received the **Nobel Prize** in Physiology or Medicine for their life's work; in the 1980s they laid the foundation for the current understanding of the biological clock (ref 2-1). With this prize the Nobel Committee wanted to indicate worldwide that being able to follow the biological clock is crucial for people and for society as a whole:

> *"**maintaining these rhythms** is **crucial to health**, and it is beneficial not only for each individual, but also for society as a whole: **a healthier society** has **lower healthcare** and **social costs**."*
>
> *Nobel Committee, 2017*

Many well-known research institutions have set up chrono-departments and chrono-laboratories, and **fundamental discoveries** are made in physiology, endocrinology, genetics, sleep science, developmental, educational and work psychology and the movement sciences. **Chronopathology**, for example, deals with the effects of a disturbed biological clock and the resulting syndromes (including shift work and jet lag). **Chronopharmacology** is also gaining ground now that it has been discovered that the exact timing of taking many medications improves their effect and effectiveness, reduces side effects and speeds recovery. Important research areas in addition to **timing of medication** are the hormone melatonin, the **effect of light**, eating patterns and human chronotypes.

**Biological clock and rhythms**

The biological clock is a genetically determined mechanism in the cells of all living things that keeps track of the day-night rhythm on Earth. Even single-celled organisms "know" what time it is. The biological clock can record the current day length and time of the year. It has a daily rhythm (circadian = cycle of approximately 24 hours) and annual rhythm (circannual = cycle of approximately 365 days). Every behaviour and every event in flora and fauna has its own optimal time: plants open and close their flowers, animals become active or inactive. The biological clock ensures that all functions take place regularly and at the right time.

That this mechanism is ingrained, and therefore the plant also opens and closes its flowers at a fixed time in a dark cupboard, was discovered as early as the 18th century. The functioning of this mechanism and the influence of daylight on it, however, could not be proven until the 20th century. Outside of chronobiology, the influence of the biological clock has only really been taken seriously **since the 1980s**. Professional sport is an area where this knowledge is applied extensively: it has been known for decades that sporting performance depends on the time of day and the personal biorhythm of the athlete.

**The master clock**

The human body consists of 30 billion cells and 100,000 km of wiring (nerve cells), each with its own cellular clock. These clocks all work harmoniously together under the direction of the different organ clocks and a master clock in the brain, the Suprachiasmatic Nucleus or **SCN**. This is a brain area just behind the eyes that consists of approximately 20,000 brain cells and receives information directly from the eyes. It has recently been discovered that even the clocks of our more than 40,000 million intestinal bacteria are controlled by the SCN!

In a cycle of approximately 24 hours (the **circadian rhythm**), the SCN regulates the rhythm of all **basic processes** in our body: sleep, digestion, body temperature, blood pressure, metabolism and hormonal balance. It also directs the daily **highs and lows** in our ability to work, learn, react and concentrate, in our alertness and in our creativity. These rhythms vary greatly per person, from extreme morning persons to extreme evening types, see part 2e and figure 5 (in which the averages of the human 24-hour rhythm are displayed).

**Synchronization and Zeitgebers**

In order to optimally adapt to the longer and shorter days of the year (or of a new location), the biological clock has a flexible rhythm of around 24 hours and a special synchronization mechanism. Our internal clock needs signals from outside the body for daily adjustment. Without these synchronization signals or "Zeitgebers" the clock would deviate from the day-night rhythm of the environment a little more each day.

The **most important** Zeitgeber for our biological clock is **morning light**. In mammals this is perceived through special light receptor cells at the back of the eye (the melanopsin cells discovered in 2002). Even most blind people perceive this light, which "resets" the clock so that it aligns with the day-night cycle. Other Zeitgebers include the timing of food intake and darkness: under the influence of dim light the clock controls, among other things, the production of melatonin which regulates our sleep rhythm.

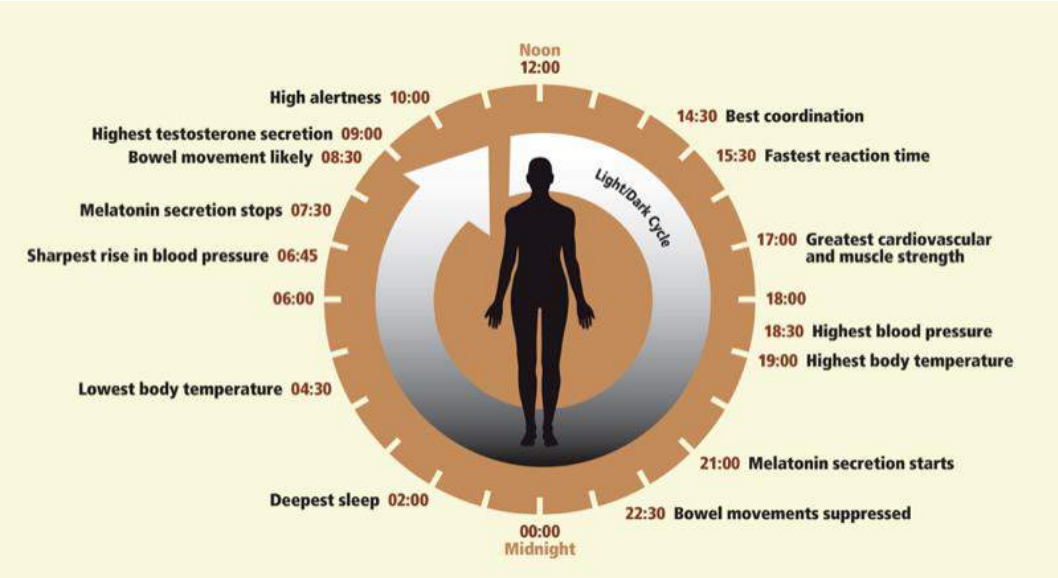



*Figure 5: the **average 24-hour rhythm** of the human body.*
*Times are based on local solar time (see part 2a),*
*highs and lows based on those of an average **day person**.*
*Depending on the personal chronotype, these*
*highs and lows can take place hours **earlier** or **later** (see part 2e).*

## 2D. THE IMPORTANCE OF SLEEP

It has now been **proven** conclusively that both short and long-term and certainly chronic **sleep deprivation** has serious consequences for human health and functioning. This is increasingly receiving media attention, partly due to the current epidemic of sleep disorders and the large-scale use of sleeping pills. The studies in this field are countless and popular science books are appearing in large numbers.

*"**Two-thirds** of adults throughout all developed nations **fail** to obtain the recommended eight hours of nightly sleep"*

*"Inadequate sleep – even moderate reductions of two to three hours for just one week – disrupts blood sugar levels so profoundly that you would be classified as **pre-diabetic**"*

*prof. Matthew Walker, 2017*

A detailed description of the consequences of sleep deprivation and sleep disorders follows in part 3a.

## 2E. CHRONOTYPES

Everyone is born with their own clock genes and has a unique biological rhythm that manifests itself in **personal timing** of **optimal functioning** and performance. We call this the chronotype. Taking your own chronotype into account appears to be essential for your physical and mental health. Staying awake too long or waking up too early leads to sleep deprivation, which in turn can lead to illnesses, disorders and accidents.

**A personal rhythm**

The distribution of chronotypes ranges from **extremely early** to **extremely late** types. The latest night person is not even sleepy when the earliest morning person is ready to get up. Science assumes that this offers an evolutionary advantage in the survival of the species. We can **roughly** divide the chronotypes into three groups: **early**, **late** and **intermediate** chronotypes. In Europe the distribution is around 15% morning person, 25% evening person and 60% day person.

**Teenage clock**

Chronotype **varies** with age. As many parents know, young children are more often early types. Because of changes in their developing brains, **adolescents** not only need much more sleep, but they also become increasingly **later chronotypes**. During adolescence (from about 10 to 25 years old) practically nobody is a morning person; we are mainly evening and day people. This peaks around 19.5 years for women and around 21 years for men. Then we slowly **shift back** to our innate chronotype.

**Measuring chronotypes**

To know which chronotype someone is, you can look at their sleep-wake behaviour on their days off and during the holidays, at what time they wake up naturally (without being awoken) and at what time they fall asleep. There are various validated psychological tests that measure the degree of "morningness" (morning type) and "eveningness" (evening type) or establish a more accurate chronotype. The most accurate methods are currently determining the biological clock phase through blood, saliva, or urine analysis.

## 2F. SOCIAL JETLAG AND TIME ZONE

**Jet lag** is a temporary sleep-wake disorder that occurs after long-haul flights where different time zones are traversed. The biological clock is out of step with the local solar time. Jet lag gets worse as more time zones are traversed and people suffer more from jet lag when they fly from west to east than the other way around. The biological rhythm and therefore all bodily processes are disrupted, and people can suffer quite a bit from this.
Because the “Zeitgebers” (sunrise and sunset and the light intensity during the day) are different at our **new location** than at home, our biological clock can adjust. This happens gradually, with about an hour a day.

**Social jet lag** is a scientific term that has been in use since 2006 to describe the degree of discrepancy between one’s own biological rhythm and the social rhythm in one’s own time zone (ref 2-3). The consequence of this discrepancy is experiencing a kind of jet lag every single day: being unable to fall asleep “on time” and being unable to wake up “on time.”
However, because we stay in the **same location,** the local "Zeitgebers" do not change and our biological clock has great difficulty adjusting to the earlier social rhythm, oftentimes failing to do so. This is the core of the "battle between biological and social times" (ref 1-5).

Regardless of your personal need for sleep (there are long sleepers and short sleepers), being awakened from your sleep causes **sleep deprivation**. If this happens for a long time, you build up **chronic** sleep deprivation. This "**sleep debt**" cannot be redeemed. The longer the social jet lag lasts, the more serious the consequences for physical and mental health, general functioning and well-being (see part 3).

### I. Difference within the geographical time zone

It appears to be **unhealthier** to live in the western part of one’s own time zone. People living in the **west** of their geographical time zone have demonstrably **more social jet lag** than people in the east of that same time zone. Several studies show that **health problems** increase, and **life expectancy** decreases as people live more towards the western part of their time zone (ref 1-4). This is the result of the "battle between biological and social times" (ref 1-5).

When the sun rises in the extreme east of a time zone at 6.30 am, then it does not rise until an hour later in the extreme west of that time zone. However, the same clock time applies to everyone within a time zone. People in the west must therefore rise more often before sunrise or earlier than desired than people in the east of a time zone. An extra hour of light in the evening leads to an average of 19 minutes less sleep, with significant effects on health and economy (ref 3-36).

If a country lies on the western edge of a geographical time zone and/ or straddles two time zones (such as Portugal and Greece), the **healthy option** is to adopt the **time zone to the west** of that geographical time zone.

### II. One-hour difference with the geographical time zone

When adopting a **whole time zone** to the east, such as with the current standard time in Western Europe, and with DST / "summertime" in the rest of Europe, the above impact is considerably **greater**. We actually live **very far to the west** within this "merged" time zone.

If the sun rises in the far east of this time zone in Warsaw and Skopje at 6.30 am then it will still be dark for two whole hours in the far west of this time zone in Galicia! From meridian Prague to meridian Alicante that is a **one-hour difference**, see also figure 2.

This is precisely what the internationally renowned chronobiologist Till Roenneberg warns about should Germany (a Central European country) choose "permanent summertime" (Eastern European Time). He predicts grave social jet lag of epidemic magnitude leading his countrymen to become "fatter, dumber and more depressed":

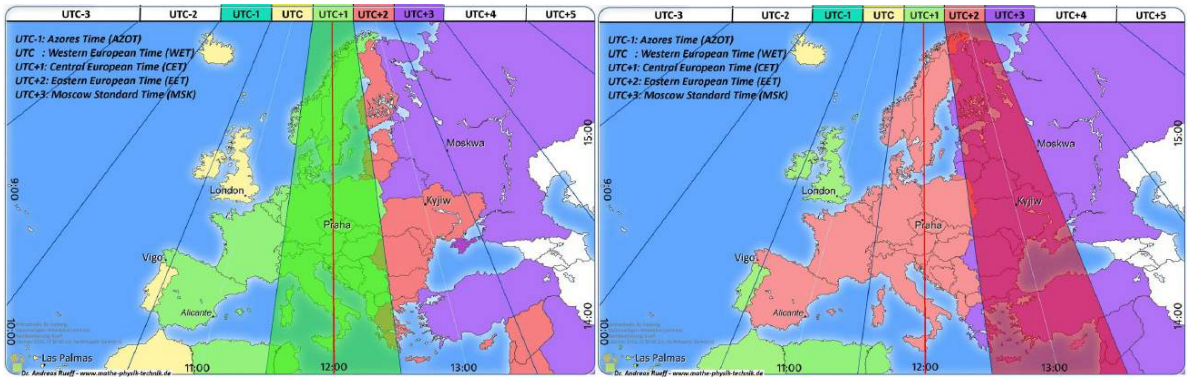
> "In an everlasting summertime, one has to get up more often while it is still pitch dark outside. Every country that does not do so will **catch up with us academically**, because it is mainly students that are affected due to learning being severely **restricted** if there is not enough sleep."
>
> *Prof. Till Roenneberg, 2018*
> *President of the World Federation of Societies for Chronobiology*

Ironically, he warns here against the situation that we already have in **Western Europe** with our **standard time** the Central European Time. This time zone is in fact already one time zone to the east of our actual time zone (see part 2a)

## III. Two-hour difference with the geographical time zone

When adopting **two whole time zones** to the east, such as with DST / "summertime" in Western Europe, the impact is **even greater**. If the sun rises in the extreme east of that time zone in Moscow at 6.30 am then it will not be light for another three hours in the extreme west in Galicia! From meridian Kiev to meridian Alicante, that is a **two-hour difference**, see figure 4. In France this is referred to as a "**double summertime**".

Since the 1970s, all of Western Europe with the exception of Great Britain has been living six to seven months of the year very **far to the west** of the Eastern European time zone. Proof of the negative effects are the increasingly later French and especially Spanish social rhythms and the resulting sleep deprivations (ref 1-5).




*Figures 2 and 4. The current time zone arrangements within the EU with standard time (UTC+1) and with DST "summertime" (UTC+2).*

## 2G. THE IMPORTANCE OF LIGHT

People who don't get **enough light** during the day and especially in the **morning** will notice this directly in their sleep patterns. Because their biological clock has not been able to reset, day people and evening people will fall asleep later than normal and morning people will wake up earlier than normal, regardless of how tired they are and whether they have slept enough.

In addition, light in the evening is also a wrong signal for the biological clock. The clock will assume that it is still day and shift to an even later time, thus increasing the social jet lag effect. Late chronotypes in particular suffer from this. It has recently been discovered that many people are more sensitive to evening light than previously thought; the production of melatonin was already half suppressed at >30 lux, the light from a small shaded-lamp or electronic device (ref 2-4).

**Light intensity**
For a healthy sleep-wake rhythm it is very important to "catch" **sufficient daylight** and **sufficient darkness** depending on the time of day. Light intensity is expressed in lux units and a person needs **at least 1000 lux** for **15-45 minutes a day** and at the right time in the **morning** to adjust their biological clock. The more light we see during the day, the earlier we will fall asleep and also the better our sleep quality will be.

How much light a person is exposed to at the right time each day **depends on** the **time zone** in which the person lives and on the **intensity of the light** in their living environment. The overview of light levels below (Figure 6) shows that homes, offices and schools are insufficiently adjusted to the required light intensity. Due to the **early daily rhythm** that often takes place indoors, most people barely get exposed to the minimum amount of 1000 lux per morning.

On the other hand, due to the growing use of artificial light, it is also much **less dark outside** at night and **early in the morning** than natural. Worldwide, light pollution increases by 2% annually and the Netherlands is a shining beacon of artificial light on the world-light map (ref. 2-6). Light pollution is not only an ecological problem (see part 3d), but it also aggravates **air pollution**: the bright light disrupts and slows down the chemical reactions that purify the air at night, so that more pollution remains in the air the next day (ref 2-7). Air pollution on the other hand is a disruptive factor that **mutes daylight** as result of which we receive **less light** during the day outside as well.

| *OUTSIDE* | | *INSIDE* |
|---|---|---|
| Sunny summer day | 125.000 lux | |
| **Daylight**, indirect sunlight | **15.000 lux** | |
| Cloudy winter day | 1.000 lux | |
| | **500 lux** | **Workplace**, sports hall |
| | **300 lux** | **Classroom**, swimming pool, gym |
| | **150 lux** | **Home** |
| Dark day | 100 lux | |
| Twilight | 10 lux | |
| Full moon | 0,1 lux | |
| Cloudy night without moonlight | 0,0001 lux | |

*Figure 6: The intensity of the ambient light, measured in lux.*
*On the left the natural light and on the right the EU standards for indoor lighting environments.*

## 3. SOCIAL CONSEQUENCES

In the previous sections we have touched on the personal and social implications of the clock changes and the influence of the biological clock. In this part we will outline the various policy areas in which these implications play an important role. Coherent multidisciplinary (literature) research as well as government advice on the subject of time and on the influence of the biological clock is necessary in the Netherlands.

### 3A. HEALTH

As indicated in parts 2a and 2b, in Western Europe we do not live in our own time zone. As a result, we start our day **one to two hours earlier** relative to sunrise than our neighbours in the Middle and East of Europe do. An extra hour is added to this difference during DST / "summertime".

**Disrupted rhythm**

Most of us are forced to adjust our sleeping and eating patterns to our living and working conditions, even if this goes against our own rhythm. And because our body clock always follows the local sun time, for most of us the extra early rhythm of life goes against our body rhythm (see parts 2c and 2e). This disruption of your biorhythm is called **chronodisruption** and is **very unhealthy** for body and mind.

**Sleep deprivation**

Good and sufficient **sleep** is **essential** for body and mind - during sleep the body recovers and the brain processes all the impressions and information received that day and embeds relevant memories. The brain works harder at night than during the day! With only one night of insufficient sleep, harmful effects can be measured in the brain and the rest of the body.

In addition, being awakened from your sleep causes sleep deprivation. If this happens structurally, you build up a long-term or chronic sleep deprivation. This "sleep debt" cannot be redeemed (ref 3-1). The longer this takes, the more serious the health consequences.

*"A consistent seven to nine-hour sleep each night is the **most effective** thing we can do to reset our brain and body health"*

*prof. Matthew Walker, 2017*

According to the latest figures from the Central Bureau of Statistics (CBS), almost one fifth of Dutch people over the age of 12 suffer from sleeping problems; that is almost three million people. Many of them resort to sleeping pills and other drugs such as the hormone melatonin that, if not administered with the correct dosage and timing, can damage the biological rhythm. It is estimated that 1.5 million Dutch people take one or more sleep medications. One in ten uses them long-term, resulting in serious health and (traffic) safety consequences. Furthermore, these drug residues end up in the environment (see part 3f)

**Effects**

Structural disruption of the biorhythm and sleep deprivation ensure the gradual, insidious disruption of **all bodily systems**, with both physical and mental consequences. For figures on these facts, we refer to organisations such as the RIVM (National Institute for Public Health and the Environment).

**A. Physical consequences**
Depending on personal aptitude increased chance of:

- Overweight and obesity
- Type 2 diabetes *
- Sleep disorders *
- High blood pressure
- Heart attacks / cardiovascular diseases **
- Delay in recovery after illness, accident or operation
- Decreased immune system
- Chronic inflammatory diseases
- Chronic muscular diseases
- Cerebral infarctions / neurological disorders
- Alzheimer's
- Dementia
- Tumor formation and accelerated growth of cancer cells **
- Excessive medication use

* The Health Council of the Netherlands concluded in 2017 that working at night increases the risk of developing sleep disorders, cardiovascular diseases and diabetes (ref 3-2).

** An additional hour of social jet lag per week increases the risk of cardiovascular disease by 11% (ref 3-3).

*** Shift work is an extreme form of chrono-disruption and in 2007 the WHO (World Health Organization) classified shift work as potentially carcinogenic.

**B. Mental consequences**
Depending on personal aptitude increased chance of:

- Stress
- Overexertion and burnout *
- Reduction of emotional capacity
- Reduction of intellectual capacity
- Slower cognitive ability
- Memory issues
- Concentration problems
- Decreased alertness
- Estimation errors
- Underperformance
- Anxiety disorders
- Addictions
- Depression
- Triggering other congenital and/or hereditary mental disorders

* As an indication: one in five 25 to 35-year-olds in the Netherlands is burned out (TNO and CBS, 2018). A burn-out costs the employer an average of € 100,000 per employee.

Finally, it is noteworthy that the health advices about limiting harmful UV rays often conflict with the actual solar time. The advice to stay out of the sun two hours before and after solar noon in Amsterdam in the summer does not apply to the clock hours 10.00 - 14.00 but to the period between 11.40 and 15.40 hours.

In the following sections we will specifically address the socio-economic consequences of the aforementioned health consequences for work, education and traffic, among other things.

**DST clock changes**

The clock changes are an additional disturbing factor as they cause an extra hour of chrono-disruption to the body. The transition to "summertime" (Eastern European Time zone) in Western Europe means **seven months** of an **additional hour of social jet lag** per day. This leads to structural sleep deprivation with consequences for physical and mental health.

At the EU Transport Committee workshop of 21-01-2019, biomedical expert prof. Dr. Acuña Castroviejo concluded the following (ref 3-4 and 3-5):

> "Disruption of the personal daily rhythm demonstrably affects more than a thousand genes. It can lead to inflammatory diseases, brain diseases, muscle diseases, cardiovascular diseases, diabetes and obesity. It promotes tumor formation and is an additional predisposition factor for cancer."

"As stated in the expert statement, there is sufficient scientific evidence about the negative effect of DST on the body clocks that all our organs depend on. That makes it irresponsible to continue with DST."

Prof. Acuña Castroviejo, 2019

In addition, worldwide the clock changes have the following acute effects when switching to "summertime":

- The number of **heart attacks** increases by 5% in the week following the switch to DST.
- The sleep deprivation (on average 40 minutes that first day) causes fatigue, reduced alertness and poorer concentration, with consequences for traffic and work.
- More and more severe work-related **accidents** occur on the first Monday after switching to DST. (Ref 3-6)
- A quarter more patients must undergo **angioplasty** that day.
- A few days of less sleep also changes our dietary habits and some people start taking more alcohol and/or sleeping pills, which can trigger **depression**.

**Most affected by the clock changes**

As an indication, a list of vulnerable population groups that are most affected by DST:

1. People who use medication and or are under treatment (for example, chemotherapy). The precise time of drug administration should be tailored to the patient's individual rhythm to increase effectiveness and to limit side effects (see part 2).
2. People with cardiovascular diseases.
3. People with sleep disorders.
4. People with Alzheimer's and other forms of dementia who need a regular rhythm and who already experience sleeping problems due to their illness.
5. People for whom it is difficult to adjust their rhythm - especially babies, small children and the elderly, and those who have to take care of them (parents and caregivers).
6. People who are late chronotypes (at least 25% of the population).

Fortunately, more and more attention is being paid to these facts. The Dutch **Brain Foundation**, for example, has indicated that changing from wintertime to summertime and back again has major consequences for

public health, as a result of which Dutch people are getting fatter and more depressed (ref 3-7). *"It is scientifically proven that the permanent introduction of our wintertime is the best option for public health. In the winter people get more morning light and, in the summer, less evening light. We **need that morning light** for our biological clock."*

**Serious gap in the National Prevention Accord**

To improve the health of many Dutch people, the National Government signed the National Prevention Accord (NPA) in November 2018 (ref 3-37). This accord establishes a large number of agreements between more than 70 Dutch organizations. The accord focuses on three topics: overweight and obesity, problem drinking and smoking. In the recorded measures **no attention** is paid to the current **unhealthy times**, which often **underlie** the aforementioned problems. The RIVM (National Institute for Public Health and the Environment) monitors the objectives of the agreement and will investigate whether the measures are of help and whether new measures should be added.

## 3B. WORK

During our "summertime" months, from April up to the end of October, the adverse effects of being out of step with one's biological clock are even stronger. Doing everything an hour earlier (getting up, working, eating, sleeping) already makes a significant difference, let alone two hours. During these seven months, the social clock deviates one hour from our standard time and two hours from our solar time, which means that most people have to start their day two hours **earlier** than what their own biological rhythm indicates.

A brief overview of the **consequences** of these **unhealthy times** in daily life and at work:

⇒ Decreased productivity
⇒ Diminished alertness
⇒ Diminished concentration and focus
⇒ Diminished creativity
⇒ Reduced capacity for assessment and decision making

This leads to, among other things:

- ✓ Poor decision making
- ✓ Underperformance
- ✓ Accidents
- ✓ Health complaints and short or long-term absenteeism

A number of these consequences lead to significant **direct costs** for trade and industry and social insurance. This runs into the billions of euros. The indirect, **invisible costs** can be related to reduced concentration, carelessness, incorrect decision making, negative mood, stress, overexertion and burnout.

"The most important finding was that people **don't adapt**
to the daily routines that deprive them of sleep,
they just become increasingly less able to function properly."

*dr. Paul Kelley, 2018*

Dr. Paul Kelley states that with social jet lag **we are all** somewhat **shift workers** (ref 3-8). This is because the formal definition of shift work is to be awake for three or more hours each night between the hours of 22.00 p.m. and 5.00 a.m., for more than 50 days a year.

In addition, worldwide the clock changes have the following **acute** socio-economic **effects** when switching to DST:

- ⇒ Employers - the first **week** after a clock change is the least productive of the year and **more accidents** occur (ref 3-9).
- ⇒ Shift workers and night workers: earn less due to the mandatory shorter shift.
- ⇒ People who have to appear in court - research shows that judges give on average 5% more severe penalties on the day of the clock change (ref 3-10).
- ⇒ Commuters and students who cycle to school are acutely confronted with a darker rush hour in the morning and an increased risk of accidents.

## 3C. EDUCATION

The social clock is leading when it comes to the times that pupils, students and employees are **expected** to **start** at school and when they can take a **break** and **eat**. The usual start and end times are based on tradition and are not aligned with the interests and needs of the pupils and students. There is no legal obstacle in the Netherlands to better adjust these school hours to our children's needs and natural rhythms.

**Dutch school times**

Most schools start their lessons at 8.30 am standard time. With **DST**, they actually start an **hour earlier** from the end of March, namely at 7.30 am standard time, for seven months out of the year. The already short lunch break also takes place one hour earlier. Add to this the fact that in Western Europe the legal standard time is already one hour ahead of our own time zone (see part 2a), and you see that our children must in fact during **seven months** out of the year start their lessons at **6.30 a.m.** Western European Time and have a quick lunch at 10.30 a.m.!

Incidentally, the distance between home and school in the Netherlands has increased in recent decades as a result of mergers and upscaling within the educational sector. Not only have biking distances increased but more young people travel by bicycle due to increased educational participation (ref 3-11). This means that many more pupils and students now have more **travel time** and have to get up even **earlier**. These extra early rising times are **very detrimental** to development, concentration and **learning** (see part 2c). And due to reduced alertness, their participation in the increasingly busy traffic also becomes more dangerous.

**The teenage clock**

Young people are not **lazy or slow** in the morning, but simply have to get up way too early. They are hard to wake up because they are not done sleeping yet, as many teenagers have to get up every day in what in effect is the middle of their **biological night** (see part 2c and 2nd). Going to bed earlier is not the solution because, due to developmental changes in the brain during adolescence, teenagers become increasingly later chronotypes, falling asleep later and also needing more sleep. Evening types naturally become even **later chronotypes**. Being alert at school at 8.30 a.m. is unnatural for them and they also **cannot physically adapt** to this regimen (ref 3-8).

The result is that at this all-important age of physical and mental development, they suffer heavy **social jet lag** and chronic sleep deprivation for a number of years. This makes them **extra susceptible** to the development of **mental** ailments and disorders, overweight and **obesity**, **diabetes**, **addictions** and other harmful behaviour. In addition, reduced memory, concentration, emotional and intellectual capacity leads to **underperformance** - precisely in the seven months of tests, exams, and the start of the new school year.

In total, in the Netherlands this affects roughly **3.5 million** pupils and students from Primary through to Academic Education. For the approximately 2 million pupils in puberty and beyond, the early school hours are extra unhealthy. And for at least **4 million** adults, including many parents, caregivers, teachers, and other educational staff, current school hours are also not optimal, unless they happen to be real morning types.

Internationally, there is a growing awareness of the **importance** of **later school hours**, in part because of the very positive research on this topic results in primary, secondary and academic education (ref 3-12 to 3-15). Healthy teaching times, geared towards the biological rhythms, are crucial for the development of pupils and students.

As far as Dutch policy is concerned, the Education motion that Parliament adopted on 18 June 2019 offers perspective: the trial with flexible school hours may continue. This makes it possible to start pilot projects with school times based on the biological rhythm of the students. Previous research has shown that teachers also consider such a timetable most suitable for the students (ref 3-16).

## 3D. TRAFFIC AND TRANSPORT

**Harmonization is a priority**

There is always resistance to change, but a one-time and lasting switch to the proper geographical time zone within Europe (see part 2) will also **simplify** many processes and agreements in the transport sector.

As indicated in parts 2a and 2b, in Western Europe we do not live in our own geographical time zone. Because of this we start our day **one hour** to **two hours** earlier than our neighbours in the Middle and East of Europe. This leads to a disrupted biological rhythm and chronic sleep deprivation for most people - see part 3a for the harmful effects on public health. However, it also has serious consequences for road safety.

Within the EU, the subject of DST clock changes lies with the Transport Commission, which leads to a great deal of attention for the subjects of Transport and Road Safety.

- Transport economist Professor P. Borkowski was asked by this Commission to approach the major European Road, Rail and Air transport players and presented his findings in the workshop of January 21st, 2019 (ref 3-17).
- Forensic psychologist Dr. Kiran Sarma also explained his 2017 meta-analysis "Impact of Daylight Saving Time on road traffic collision risk: a systematic review" in this workshop (ref 3-18).

**EU Transport**

Prof. Borkowski concludes that the clock changes **do not** produce any **benefits** and, in fact, cause **minor expenses** for all transport sectors. Maintaining the current system implies the continuation of the current costs twice a year. Abolishing the clock changes would only mean a one-time expense for the airline industry.

The transport industry therefore strongly **supports abolishing** the time changes and expects small savings and even modest operational **profits.** In addition, the greatest intangible **benefits** will be for the **passengers** ("strong positive effect") through better transfer connections to other public transport services.

Aviation has been operating with **UTC** (Coordinated Universal Time) internally and internationally for years and only converts to local times as a service to passengers. Adjusting those calculations **costs practically nothing** and the existing schedules can remain **intact**. The larger airports expect the **greatest benefits** by not having to redistribute a number of timeslots every clock change. For the airlines, the adjustment of the slots to the definitive time zone will mean a **one-time** expenditure.

The entire **European transport sector** says: **Go for it** but ensure that the changes take place in a coordinated manner so that new timetables do not have to be constantly adjusted.

**Cross-border exchange traffic**

Worldwide, several fixed time zones (even within one large country) are **no problem** for transport and logistics. The border between the geographic Western and Central European time zones runs conveniently between the Benelux and France on the one hand and Germany, Switzerland and Italy on the other. In the event of a time difference between neighbouring countries, convenience and clarity about the local clock times will continue to exist as a result of the current digitization: crossing the border, mobile telephones and on-board computers **automatically** adjust to the local time.

For railway traffic, an hour's time difference between the Netherlands and Germany would mean relief during rush hour. Life in one's own time zone would also have a positive impact on the behaviour of passengers and other stakeholders: social jet lag causes more unhealthy and unsafe behaviour in and around the trains.

**Road safety**

For the Dutch mobility policies, the time system choice should be based as much as possible on scientific knowledge and facts, at national level and preferably at European level. The social costs of traffic accidents are estimated at around **14 billion euro** in 2015 (€13.0 to €15.4 billion), around 2% of gross domestic product (GDP) (ref 3-19).

A large European study shows that 6-34% (depending on the country) of car accidents are a **direct result** of fatigue and **sleeping problems** (ref 3-20). According to a conservative estimate by SWOV (Foundation for Road Safety Research), based on foreign studies, driver **fatigue** occurs in 10% to 15% of **serious** traffic accidents (ref 3-21). Switching to "permanent summertime" (Eastern European Time all year round) will only **exacerbate** this problem (see part 2).

*"When someone becomes too tired, the pressure to sleep increases causing drowsiness, micro sleeps, and unintended sleep. One of the first effects of drowsiness is our **diminishing awareness** of how tired we really are. […] there is consistent evidence that this **inability** to judge our own tiredness and respond sensibly is a cause of the 20% of serious injuries occurring from road accidents."*

*dr. Paul Kelley, 2018*

**a. When maintaining clock changes**
Road users must be as rested, fit and alert as possible. Driving whilst sleep deprived (drowsy driving) is just as dangerous as driving under the influence of alcohol. For day persons and evening persons in Western Europe, a total of around 60% and 25% of the population, it is already difficult enough to be alert early in the morning during the current standard time from November to March. Getting up an hour earlier during the seven months of April to October is a cause of chronic sleep deprivation for many people and therefore an important **road safety problem**.

**b. With "permanent summertime"**
With year-round Eastern European Time in the Netherlands, the sun will not rise until after 8.30 a.m. for four months out of the year. In mid-winter the sun will not rise until 9.45 a.m. There will be more dark morning rush hours and more evening rush hours with backlight, or a very low sun head-on. For professions who work outside and often start at 7 or 8 a.m. it also means that they have to work an extra hour in the dark and have to participate in traffic earlier in the day all year round, often with heavy vehicles.
The greater social jet lag and therefore sleep deprivation leads to reduced alertness in the morning and extra fatigue in the evening rush hours. As a result, more chance of **accidents** on the road. This particularly affects the group of vulnerable road users: the large group of sleepy **students** on their bikes between 8:00 AM and 9:00 AM (see part 3c). They will then have to travel to school **15 weeks** a year in the dark.

**c. With permanent Central European (standard) time**
Students go to school 5 weeks a year in the dark.

**d. With permanent Western European Time**
Students **never** have to cycle, walk or drive to school in the dark!

**Investigation**
There is little to no Dutch research on road safety and clock changes. The 2013 SWOV (Foundation for Road Safety Research) report on the relationship between the start of wintertime and the number of road casualties is only a graphical analysis based on assumptions. Numbers are not mentioned and there is no statistical substantiation of the claims. SWOV states:

> "Answering such a question also requires a statistical analysis, to try to separate the contribution of chance from the actual differences in risk due to the **changed light conditions** during the afternoon rush hour."

This question was answered in 2017 with a broad scientific meta-analysis commissioned by the Irish government (ref 3-22 and 3-18). In this study, 24 major international studies on road safety during clock changes were examined. Conclusion: in terms of road safety, there is **no convincing evidence** of the benefits of the clock changes. In contrast to the assumptions in the SWOV report, **no substantiation** of the **Light Shift hypothesis** was found.

The Light Shift hypothesis is the assertion that moving **visibility** from the morning to the evening rush hour would mean a predictable and consistent net improvement in road safety. But there are many **more risk factors** involved in road safety than just visibility. For example, there is the location within the time zone (longitude and latitude) and associated light, the weather, holiday periods, driving behaviour and especially the consequences of the epidemically occurring **sleep deprivation**.

In the explanation of this study, Dr. Sarma also states that in Great Britain and Ireland it has often been proposed to switch to the British summertime (Central European Time) (ref 3-18). To this end, three studies are often mentioned that seem to support the Light Shift hypothesis. These studies, however, use data from

the **British Standard Time experiment**, when Great Britain lived continuously on Central European Time for nearly three years from 1968-1971.

Dr. Sarma emphasizes that the British Standard Time experiment is almost **50 years old** and that the world has changed significantly over these past five decades: traffic density, driving behaviour, infrastructure and even car technology (seat belts, ABS, airbags). As a result, the outcomes of those experiments cannot be used in our current situation. In addition, the results cannot be generalized to other countries due to **location** (longitude and latitude) **and light incidence**.

**Mobility alliance**

There are major concerns about mobility in the Netherlands. On June 12th, 2019, the Mobility Alliance (a broad partnership of 24 organizations) launched the 2030 Delta Plan: "High time for mobility" (ref 3-23). With the clock at two to twelve, it is made clear that mobility in the Netherlands must **urgently** be made smarter, more flexible, safer and greener. However, the influence of that clock is left out of the plan entirely. A smart and flexible **time policy** is still missing, while the seriousness and urgency of the problems will only increase. As stated in the 2030 Delta Plan, the number of cars and cyclists continues to steadily increase. It is predicted that e.g. the number of seriously injured two-wheelers will rise from 17,264 in 2017 to 27,180 in 2030!

*"Scientific studies show that after 22 hours without sleep, human performance is impaired to the same level as that of someone who is **legally drunk**"*

*prof. Matthew Walker, 2017*

## 3E. SAFETY

Awareness of the importance of healthy time use for safety applies especially to the following areas:

**In and around the home**

Most accidents occur in and around the house. Figures from the RIVM Lifestyle Monitor (ref 3-24) show that home, garden and kitchen accidents lead to millions of injuries per year, half of which must be treated medically. Given the current knowledge about the importance of good sleep for alertness and judgment and about the influence of one's personal rhythm on good sleep, it is clear that an unhealthy sleep-wake rhythm and the resulting sleep deprivation can be seen as an important cause of these accidents. Here too, the extra social jet lag caused by the clock changes and wrong time zones is a risk-increasing factor.

*"Sleep loss causes a marked **decline** in waking **performance**, **judgement** and **decision-making**."*

*dr. Paul Kelley, 2018*

**Emergency services / Care**

Working at "non-optimal" times entails risks of errors and accidents: the greatest risk of errors and accidents lies in the night hours. Shift and night shift workers in the emergency and health services, such as First aid / ambulances, Fire departments and Regional Police, already have to deal with this fact. The extra impact on alertness due to an hour or two of additional social jet lag only increases these risks.

**National safety**
It should be clear that for national security purposes, both the national police and the military police, army, air force and navy must be well rested. Here too, an hour or two additional social jet lag seriously impedes alertness and **judgement**. The navy used to take chronotypes into account, nowadays they do not do so anymore. Even though the best possible day rhythms and good and sufficient sleep are extremely important for the **alertness** of the troops.

*"Negative attitudes to sleep in the military and other employment remains common."*

*"Working in any high-risk environment becomes much more dangerous if you have extreme drowsiness or short bursts of sleep."*

*dr. Paul Kelley, 2018*

**International safety**
The social consequences of sleep deprivation, night work and sleep disorders are far from small-scale. A number of the **greatest** human and environmental **disasters** the world has experienced have been attributed to these issues. Think of the biggest industrial accident ever at the Union Carbide pesticide plant in Bhopal India in 1984, the nuclear meltdowns of Three Mile Island and Chernobyl and the sinking of the cruise ship Star Princess and the oil tanker Exxon Valdez. The NASA Space Shuttle Challenger also crashed due to incorrect decisions traced back to lack of sleep (ref 3-25).

*The persistence of the myth about excessive waking hours and shorter sleep hours being good is remarkable, depressing and dangerous."*

*dr. Paul Kelley, 2018*

## 3F. ENERGY AND ENVIRONMENT

Internationally people are convinced that DST does not save energy and, depending on location, even costs extra energy (heating and air conditioning). Several time zones are actually favourable for energy transport. Time use has a major impact on the environment and biodiversity.

**Energy**
At the EU level, the energy sector supports the abolishing of time changes in a coordinated manner and expects low adjustment costs (ref 3-26). All recent strategic studies show that the evidence for energy savings from the clock changes is ambiguous and that the **benefits** are **very small** / marginal. In addition, for example, the 23-hour days (when changing to DST) are a complicating factor in cross-border gas transport.

During the seven-month-long "summertime" (Eastern European Time) in the Netherlands we already need **extra lighting** on dark mornings in the spring and autumn. In addition, the use of **air conditioners and fans** is growing, as people try to fall asleep earlier in the day (because they have to go to bed earlier) on the increasingly warmer summer nights. The same goes for extra **heating** on colder mornings, because we all have to start work earlier on DST. As an example, consider the construction industry: in the Netherlands they usually work from 7:30 AM to 4:00 PM. In the hours before sunrise it is not only dark but also the coldest time of day, which means that many extra lamps and heat sources are needed for construction crews to work.

**Energy transport - towards a more balanced distribution**
In the current situation (Western Europe living on Central European time) the energy consumption peaks all fall at the same time. This is unfavourable for the energy sector. Less energy generation and energy storage are required if peak consumption is better distributed throughout the day. From that perspective, **time difference** with other **(neighbouring) countries** is also **beneficial**.

**Environment**
Clock changes and the wrong time zone cause extra air pollution, light pollution, water pollution and noise pollution, with a huge impact on flora, fauna, ecosystems and biodiversity. In addition, extra air pollution also has serious consequences for our cultural heritage - it not only affects nature but also our monuments (ref 3-28).

- **Air pollution:** An important cause of air pollution are the **extra traffic jams** because of accidents caused by DST. The **timing** of the traffic jams is also important. Traffic jams at times of day when **UV radiation** is the **strongest** produce much more air pollution. The stronger the UV radiation from the sun, the faster photochemical air pollution forms (including ozone and peroxyacetyl nitrate) from the exhaust gases. The same applies to the emissions from barbecues and outdoor fireplaces.

  Positive effect: **one-hour time difference** between neighbouring countries such as the Netherlands and Germany will spread the emissions, which will reduce the air pollution peaks.
  There are no known negative environmental effects of having an hour time difference with a neighbouring country.

- **Light pollution**: seriously disrupts the day and night rhythm of animals and plants. This applies in the extreme for greenhouse country the Netherlands (ref 2-6). Light pollution leads to ecological damage caused by impairment of growth and lifestyle. Insects fall dead from the sky, birds display disturbed breeding behaviour and nocturnal animals become less active at night (ref 3-27).

  The agricultural sector is also affected. Day animals, including cows, chickens and pigs, all need sunlight and darkness at the right times of day to stay healthy. This also has an effect on the additional use of medication in animal husbandry, which in turn ends up polluting the environment.

- **Water pollution**: the residues of all additional sleeping pills, sedatives and other medication that people need because of aggravated social jet lag caused by the clock changes and wrong time zones (see part 3a) end up in the groundwater. The same applies to the aforementioned additional medication in animal husbandry.

- **Noise pollution**: due to DST, the noise pollution caused by traffic, construction and other noise-intensive activities also starts one **hour earlier** for seven months out of the year. This causes extra social jet lag because it also **wakes up** those people who do not necessarily have to start their day an hour earlier. In addition, activities that last longer into the evening may cause **extra traffic** and other noise nuisance in the evening. In other words: in the "summertime" the majority of people have to **go to bed an hour earlier** to **get up** an hour earlier. This is difficult enough as is because the evenings are still warm and light, and the body cannot fall into sleep mode easily. Sound pollution in the evening adds **extra burden** to this effect.

## 3G. FINANCIAL AND ECONOMIC CONSEQUENCES

The social consequences of living with clock changes and in the wrong time zone have a **huge financial impact**; it is very damaging to the individual and to society at large, especially in the areas of health, work and education. There are both **short-term and long-term consequences** (see heading A-C below).

The indirect costs and immaterial impact can hardly be calculated, but the direct costs alone run into the billions of euros. Measures are needed in **all sectors**; without targeted policy the costs will only increase. Abandoning the clock changes and switching to the correct time zone means a one-time minimal expense. In return there are **enormous benefits** to a good and healthy time policy within the EU.

It is urgent to have sound economic research done as quickly as possible. It is up to the government advisory boards and agencies to come to a fully substantiated overview of relevant figures and facts.

As an indication, a few figures:

- 2% of GNP: the cost of sleep disorders (ref 1-4)
- 13% higher risk of death for people who sleep less than six hours per night on average compared to people who sleep at least seven hours per night (ref 3-29)
- 11% more chance of cardiovascular disease per extra hour of social jet lag in the week (ref 3-3)
- 5% increase in the number of heart attacks in the week after the change to DST
- 25% more patients must undergo angioplasty on the day of change to DST
- 2 million pupils from puberty onwards have school hours that are too early and therefore extra unhealthy.
- 4 million parents, caregivers, teachers and other stakeholders also experience the harmful effects of these too early and therefore extra unhealthy school hours
- 1.23 million workdays per year loss in the United States due to sleep deprivation (ref 3-29)
- 3% of GDP: the loss due to sleep deprivation in the United States; more sleep would add billions of dollars to the economy (ref 3-29)
- 207,000 working days average loss per year in the UK due to sleep deprivation (ref 3-29)
- £50 billion annual loss in the UK through reduced productivity and illness due to sleep deprivation; the equivalent to 1.9% of GDP (ref 3-29)
- 604,000 workdays average loss per year in Japan due to sleep deprivation (ref 3-29)
- 209,000 workdays average loss per year in Germany due to sleep deprivation (ref 3-29)
- 78,000 workdays average loss per year in Canada due to sleep deprivation (ref 3-29)
- €630 billion annual loss among the first 20 countries on the OECD (Organization for Economic Cooperation and Development) list due to sleep deprivation among employees (ref 3-30)
- 20% of 25- to 35-year olds in the Netherlands get burned out. A burn-out costs the employer an average of € 100,000 per employee
- $434 million in costs of lost sleep through health and reduced productivity in the US in 2013, specified per city in the "Lost-Hour Economic Index" (ref 3-31 and 3-32)
- $2 billion in estimated clock switching costs in the US - just spending ten minutes per person twice a year on changing clocks. Calculated twice a year for ten minutes per household, this would "only" cost $1 billion (ref 3-31)
- $31 billion or more loss in the US alone through the increase of the well-known "weekend effect" on the stock market by 200-500% on the Monday after the clock change to DST (ref 3-34)
- 1.5 million Dutch people who are estimated to take one or more sleeping medications. 1 in 10 uses them long-term, with serious health and (traffic) safety consequences. In addition, all drug residues end up in the environment

- €31 billion per year in environmental damage from harmful emissions. Most environmental damage is caused by traffic and transport: more than €12 billion in damage per year (ref 3-33)
- Millions of injuries per year from home, garden and kitchen accidents, half of which must be treated medically
- 200% increased risk of injury when sleeping only five to six hours a night during one season, compared to an average of nine hours per night's sleep (ref 2-2)
- 460% more diagnostic errors made by junior doctors who do a 30-hour-plus rotation than if they are well rested. The same tired doctors will commit 36% more serious medical errors compared to those who work in rotations of 16 hours or less. (ref 2-2)
- 170% more likelihood that senior surgeons make serious surgical errors if they have slept for six hours or less, compared to if they have slept well (ref 2-2)
- 11% more chance of being overweight for people who live on the western side of a time zone
- 21% more likely to be obese for people living on the western side of a time zone
- 19% more chance of a heart attack for people living on the western side of a time zone
- 5% higher chance of breast cancer for people living on the western side of a time zone
- €14 billion (€13.0 to €15.4 billion), approximately 2% of the GDP, in estimated social costs of traffic accidents in the Netherlands in 2015 (ref 3-19)
- 6-34% (depending on the country) of car accidents are a direct result of fatigue and sleeping problems (ref 3-20)
- 10-15% (conservative estimate) of serious traffic accidents relates to driver fatigue (ref 3-21). Switching to permanent Eastern European Time will only exacerbate this problem.

**A. Short-term effects on or immediately after the clock changes:**

- The number of heart attacks increases by 5% in the week following the change to DST
- More and more serious work-related accidents occur on the first Monday after changing to DST
- A quarter more patients must undergo angioplasty on that day
- Fatigue, reduced alertness and poorer concentration due to sleep deprivation, resulting in more accidents and employees being less productive. An additional expense on top of the long-term direct and indirect costs
- The days just after the clock changes are extra risky in traffic and more accidents can occur
- IT costs as a result of taking clock changes into account when developing software

**B. Long-term consequences of seven months of DST** ("summertime"):

- Physical consequences such as sleep disorders, diabetes, overweight and obesity, cardiovascular diseases, chronic diseases and cancer; with the associated (chronic) medication use, treatments and social facilities
- Mental consequences such as mood disorders, concentration problems, burnout and depression; with the associated (chronic) medication use, treatments and social provisions
- Wrong decisions due to lack of alertness, fitness and preparedness
- Decreasing local, national and international safety (online and offline)
- Accidents - these can lead not only to serious production losses and material damage, but also to immaterial damage and long-term treatments:
    - Accidents in and around the home (millions of injuries per year)
    - Traffic accidents on the road, in the air and on the water
    - Business accidents

- Under-performance and poor performance in education and at work
- Absenteeism in education and at work
- Infringement on personal relationships and general well-being
- Energy: adverse consumption peaks
- Damage to flora, fauna, ecosystems and biodiversity
- Damage to cultural heritage

**C. Long-term effects of year-long DST** ("permanent summertime"):

According to the chronobiologists, the above-mentioned **long-term effects** of the clock changes will only get **worse** with "permanent summertime" because we will have to get up an hour earlier in winter as well. For many people this will lead to even **greater social jet lag** than during the other seasons because many people also have later rhythms in the winter due to the lack of sunlight (ref 1-3).

We know this through a number of large-scale "social experiments": e.g. Germany in WW2, the United States after WW2, the United Kingdom[1] and the United States in the 70s and Russia in 2004 have all tried "permanent summertime" and all **revoked** this decision **after a few years**.

In addition to the fact that, time and time again, it turns out to be a very unpopular measure, there is significantly more winter depression (Seasonal Affective Disorder), social jet lag and poorer school performance measured when continuously living on a more eastern time (ref 1-2 through 1-5). As soon as a country abandons "permanent summertime", the amount of serious social jet lag is significantly reduced and the number of people without social jet lag doubles.

This effect of living on a clock time that is more to the east or earlier than one's own geographical time (see part 2f) has very recently been **economically researched** in the United States (ref 3-35 and 3-36):

*"Individuals on the late sunset side of a time zone boundary are more likely to be sleep deprived, more likely to sleep less than 6 hours, and less likely to sleep at least 8 hours. The effects are larger among individuals with early working schedules and among individuals with children of school age.*

*People on the late side of sunset across U.S. time zones were 11 percent more likely, on average, to be overweight and 21 percent more likely to be obese. Diabetes was more prevalent, and the risk of heart attack increased by 19 percent. Breast cancer rates were slightly elevated, too - about 5 percent higher than average.*

*The authors also found economic differences. Sleeping less is known to adversely affect productivity. As a result, the researchers found, "wages tend to be 3 percent lower on the late sunset side of the time zone border, suggesting negative effects on economic productivity."*

[1] British "summertime" (the Central European Time) is our current standard time, even though we all geographically belong to the Western European time zone. It should be noted that many **"permanent summertime" experiments** performed in other countries are comparable to adopting **"permanent wintertime" in Western Europe** (one time zone to the east of our geographical time zone).

**D. Long-term consequences for Western Europe:**

As explained in part 2f, the above-mentioned effects of “permanent DST / summertime” are actually the effects of “**permanent wintertime**” for Western Europe (with the exception of Great Britain). This is because our standard time the Central European Time is already one time zone / hour to the east of our own geographic Western European Time zone:

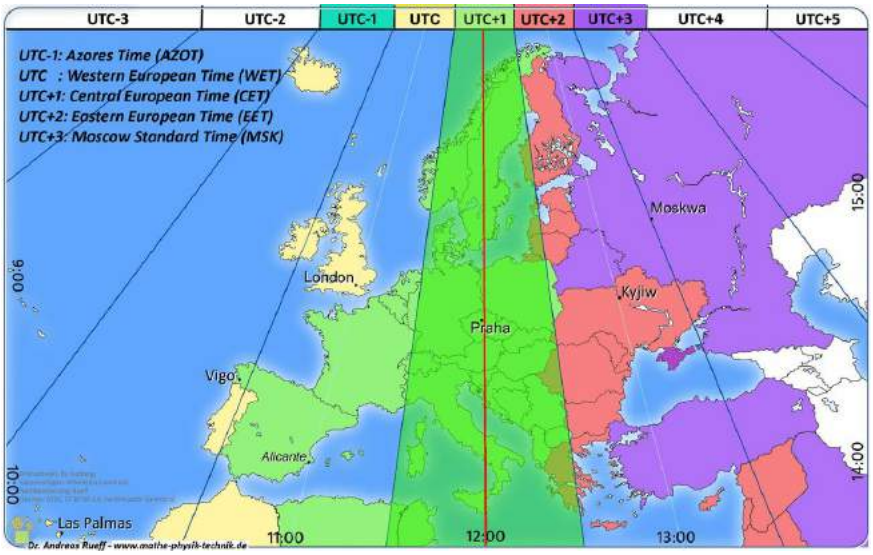



*Figure 2. The current time zone arrangement within the EU, since WWII with standard time UTC+1.*

In the Netherlands, Belgium, Luxembourg, France and Spain we have not been living in our own West European time zone for almost 75 years now. Since the 1970s we’ve also had to live with a "**double summertime**" for six to seven months of the year. The negative effects of the DST clock change and "summertime" therefore are more severe for these five countries than for the Central and Eastern European member states. Western Europeans are thereby placed at a **disadvantage** both in terms of health and socio-economically.

This EU proposal is therefore an excellent opportunity for the Netherlands and **the whole of Western Europe** to **shortly cash in** on all acquired insights into the relationship between time, health and economy. For an obvious win-win solution see the Conclusions below.

*“The current time system of changing twice a year between standard time (UTC+1) and daylight saving time (UTC+2) is accompanied by acute sleep disturbances and health effects, of which the increase in heart attacks during the spring change is the most obvious. These identified acute effects disappear when choosing a permanent time setting. With such a decision, **permanent standard time (UTC+1)** has a **clear preference** from a **health perspective** over permanent summertime (UTC+2), and it is even worth **considering** setting Greenwich Mean Time **(UTC+0) for the Netherlands**."*

*Conclusion RIVM, October 15th, 2019 (ref. 1-8)*

# 4. CONCLUSIONS

## HIGH TIME FOR A TIME POLICY!

The Gezondtijd! team endorses Minister Ollongren's position that **additional** multidisciplinary research is necessary. Together with an interdepartmental approach (health, education, economic affairs) and pertinent European coordination, this is required to arrive at a coherent and profitable policy on time use.

The current clock changes must be seen in the perspective of the **24 global time zones**, which are based on the **geographic location** of countries relative to the sun. The starting point of this time zone system is the natural rhythm of light and darkness, a process that is of vital importance to human beings, nature and the environment. Due to digitization, globalization and financialization, we are now dictated by the constraints of the industrial clock, even though it goes against the natural rhythm of our biological clock. And unlike the social clock, our biological clock is not so easy to change.

This position paper makes clear how **important** it is to live on your own time zone, with sufficient daylight and sufficient sleep according to your own circadian day and night rhythm or chronotype. Ground-breaking studies in the young science of chronobiology (Nobel Prize 2017) show how our personal biological clock has a fundamental impact on our **health**, our **functioning** and our **achievements.** Socially there is still very little awareness of and knowledge about the importance and implications of these findings. The **scientific** consensus is clear: clock changes and "permanent summertime" are unhealthy for people, the environment and the economy.

The **widely substantiated** expert **advice** is to abandon clock changes worldwide and to adopt a country's natural time zone: "**permanent standard time**" on the country's **own** geographic **time zone**. It is precisely in this digital age that this has become very easy to implement - with our digital tools, time zone limits are no longer an obstacle to social or economic traffic. The dreaded "patchwork quilt" of time zones is prevented if all countries simply adopt their own geographic time zone as standard time after abolishing the **unhealthy DST clock changes**. In Western Europe these time zone borders happen to correspond nicely with most national borders.

## DUTCH BEST OPTION

So far, the Dutch government has presumed 3 options. This paper is consistent with the **scientific advice** to add our **own geographical time zone** as an option and to prioritize it as the most responsible choice:

1. Permanent **Western European Time** (WET): the geographical time zone
2. Permanent Central European Time (CET): the current standard time or "wintertime"
3. Maintaining current clock changes:
    - 5 months "wintertime" / CET
    - 7 months "summertime" / OET
4. Permanent Eastern European Time (OET): the current "summertime"

– science advises against this option.

For the Netherlands, abolishing the clock changes and permanently returning to the current **standard time** (Central European Time) is a first step in this direction. This option provides many immediate benefits and can be implemented **quickly**, **easily** and **cheaply**.

## EUROPEAN BEST OPTION

In the same fashion, the **scientifically substantiated** optimal choice for the rest of Europe is also to move away from the clock changes and adopt "permanent standard time", preferably "**permanent standard time**" on a country's **own geographical time zone**.

This would mean the following:

⇒ For **Eastern** Europe the **Eastern** European Time (OET)
⇒ For **Central** Europe the **Central** European Time (MET)
⇒ For **Western** Europe the **Western** European Time (WET)
⇒ For Portugal, Ireland, Canary Islands (and Iceland): **Azores** Time (AZOT)

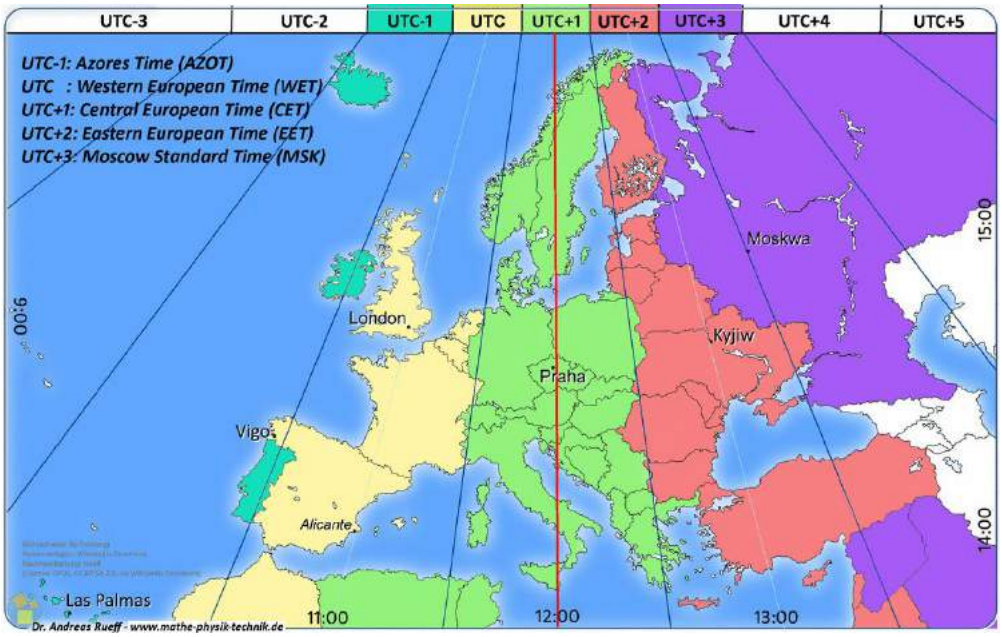



*Figure 3: The ideal time zone arrangement within the European Union.*

For all Member States in Central and Eastern Europe and for Great Britain, this means abolishing DST and permanently adopting their current standard time. For the Netherlands, Belgium, Luxembourg, France and Spain, this means switching to Western European Time (WET).

This simple definitive solution of moving to one's own "solar time" leads to a special win-win situation.

In all social sectors, the **harmful** immaterial and material consequences can be considerably **reduced** and **prevented**. This not only saves billions of euros, but also improves **health**, **functioning** and **achievements** on a large scale and across the entire population. An absolute requisite for the new knowledge economy.

*"**Sleep** should therefore be considered a life-support system; a universal national **healthcare plan** still waiting to be fully embraced by medicine, and society at large."*

*prof. Matthew Walker, 2017*

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## ABOUT THE AUTHORS

**Gezondtijd!*** is a collaboration between several advocates for a healthier time policy in the Netherlands: 'Platform Betere Tijden' (Better Times Platform), 'Standaardtijd' (Standard time) and 'Stop de zomertijd, de klok moet terug' (Stop the summertime, the clock has to turn back). The 'Stop the summertime' petition has has been signed more than 63.900 times.

**Conny Bergé**: human rights activist
Activist since 1968. Committed to promote human rights and democracy through non-profit organizations and board positions, with a focus on education and economics. Founder and coordinator of 'Tijd voor school' (Time for School) in 1976. Founded the PEP International foundation in 1986 and co-founded Platform Betere Tijden in 2015.

**Ticia Luengo Hendriks**: psychologist & initiator
Advocate since 2010. Connects people and ideas and is passionate about positive change in a wide variety of fields including children's rights, giftedness, education and time use. Founded the Dutch branch of B-Society in 2011 and co-founded Platform Betere Tijden in 2015.

**Source material**
The content of this paper is based on the latest scientific knowledge and was fact checked by chronobiologist **dr. Marijke Gordijn**, CEO of Chrono@Work, researcher at the Chronobiology group of the University of Groningen and board member of the Good Light Group.

[* 'Health time!' - a Dutch play on words referring to 'gezondheid' = health and 'tijd' = time]