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„Building archives for the future: Some remarks on the constructing of less energy consuming archives“

Summary:

Over the last decade the price of a barrel oil (brent) rised from around 20 \$ to over 100 \$ with a peak of more than 140 \$ in the year 2008. The International Energy Agency (IEA) predicts in the long term a price over 200 \$. This will means a financial burden each archive must face in the future, that might limit other professional activities due to budget restrictions. Combined with the threats of the expected effects of the accelerating climate change – this might be reason enough to think about ways to run archives less energy consuming than today.

In Germany the concept of natural climate controlled storage rooms for archives was developed from the 1970s onwards. In this paper a few of these models are presented in some detail. The latest development is to build even energy producing buildings. These might be ways to become more independent from rising energy prizes.

When in the year 2008 the price of oil has risen to a peak of more than 140 \$ per barrel (brent), the newspapers feared a new oil crisis coming like in the 1970s. Although the price declined afterwards, it stabilised on a very high level and even the International Energy Agency (IEA) predicts in the long term an oil price of well over 200 \$.¹ This alone should be enough reason for archives as for all other institutions to look for possibilities to cut down energy consumption in buildings, work-flows and mobility, since a lot of the budget of archives might be dedicated to this in the future. Furthermore the consumption of energy is at the moment very closely related with the burning of fossil fuels that contributes heavily to the man made climate change. Even though there are no studies about the effect of the climate change to archives we have to face it, that it very likely will have more negative effects than positive. For example experts predict for the area in Germany where the new building of the Bundesarchiv was erected, that there will be a rise in rainfall and especially heavy rain in winter and a higher probability for droughts in summer. But even the rain in summer is predicted to

be connected with thunder storm.² Therefore there is a higher risk of flooding in winter (and summer) and a higher risk of fire in summer that we have to incorporate in the concept of the building. It is to fear that in other regions of the earth the effect on archives will be much more dangerous – for example if one think about archive buildings near the sea and a predicted rise of the sea level in the next decades.

Looking at the latest archive buildings³ in Germany one sees that attempts to cut down energy consumption is a big issue concerning the storage areas of archive. What is less in focus are the spaces for the public and the working areas for the staff of archives. But of course in order to reduce energy consumption we have to look at all areas of an archive building even if the main focus might be for a while on the storage of archival material.

Following the recommendations of the ISO 11799⁴ concerning the temperature and relative humidity for the storage of different archival materials one is often confronted with the need to communicate to technicians and planners of archive buildings the necessary parameters. But not only temperature and relative humidity are important here, one also has to decide on how much technical support one would like for the running of the repository, since normally technicians tend to propose a way with implementing very heavily technical support.

This illustration⁵ tries to reduce the full complexity of this decision to the shown four stages that should be prototypical for the different possible ways to create the right indoor climate. The main question of course is how much technical support one needs for reaching that aim. The main thesis here is that it is best to reduce this support as much as possible. Obviously this reduction of technical air condition will correspond with

¹ Palm, Regine: Energieagentur erwartet Ölpreis von 200 Dollar, in: Handelsblatt 6.11.2008, <http://www.handelsblatt.com/finanzen/rohstoffe/energieagentur-erwartet-oelpreis-von-200-dollar;2081787> (last visited: 4. july 2012)

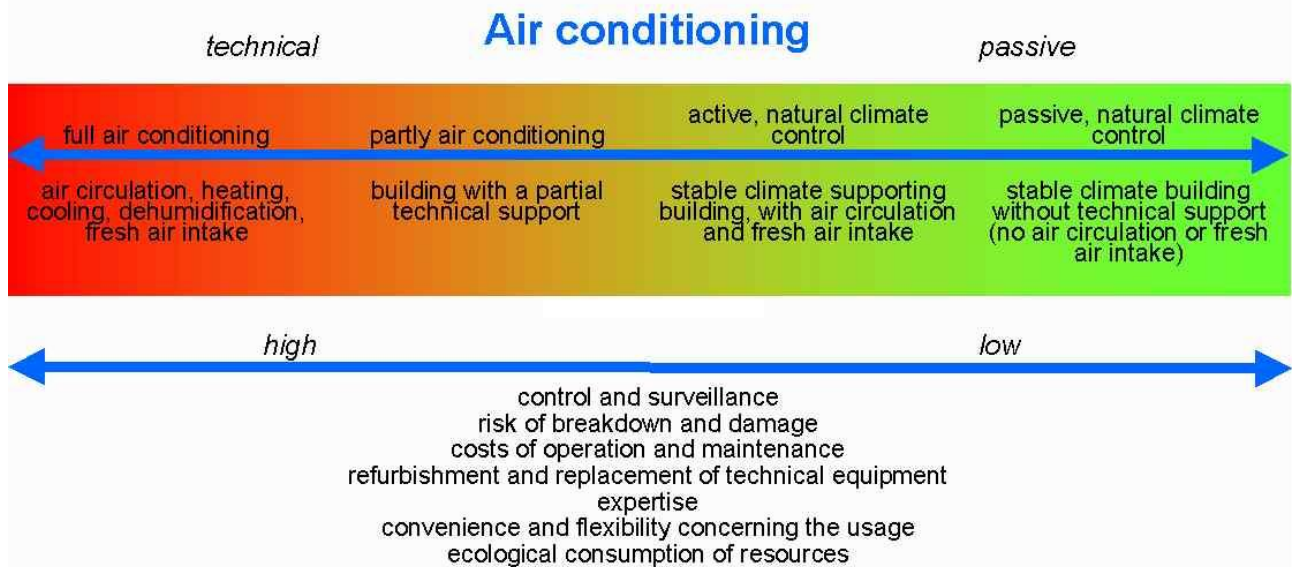
² Umweltbundesamt (ed.): Deutschland im Klimawandel: Anpassung ist notwendig, Dessau 2008 <http://www.umweltdaten.de/publikationen/fpdf-l/3468.pdf> (zuletzt besucht 4.7.2012). see also „Deutsche Anpassungsstrategie an den Klimawandel vom Bundeskabinett am 17. Dezember 2008 beschlossen“, http://www.bmu.de/files/pdfs/allgemein/application/pdf/das_gesamt_bf.pdf (last visited: 4. july 2012).

³ For some examples from libraries see: Library & Archives Facing the Challenges of Sustainable Development. in: International Preservation News 44, 2008, (last visited 12. july 2012) and Energy Savings and Preservation in Libraries and Archives in: International Preservation News 55, 2011, <http://www.ifla.org/files/pac/ipn/IPN%2055%20web%206%20megas.pdf> (last visited, 12. july 2012)

⁴ The DIN ISO 11799:2005 recommends for paper that is often used 14^oC -18^oC and 35-50% RH - with only 1^oC and 3%RH changing per day. Haberditzl, Anna: Kleine Mühen – große Wirkung. Maßnahmen der passiven Konservierung bei der Lagerung, Verpackung und Nutzung von Archiv- und Bibliotheksgut, in: Weber, Hartmut (Hg.) Bestandserhaltung in Archiven und Museen, Stuttgart 1992, p. 71-89, here p. 73, goes up to maximum values of 25^oC and 65% RH.

⁵ I owe this illustration to Prof. Dr. Mario Glauert.

As less air conditioning as possible, as much as necessary



a reduction in energy consumption. But this is only one advantage – it is also positive regarding questions of safety. If one relies mainly on technical support for reaching the projected indoor climate this climate will change quite rapidly if the technical air conditions stops working. Therefore if one relies on the technical support one has to guarantee that there is at least a redundant technical installation planned that takes over when the first installation fails. Of course that means significant higher costs for installing the system and in the long term also higher running costs. And to be quit honest I fear only few archives will have enough resources for such a double installation for redundancy.

But if one relies on passive means only to achieve the projected climate the main problem might be that there is no way of actively manipulating it in cases it might be for example to warm or to humid. Therefore it might be reasonable to rely on some technical support – the Bundesarchiv for example favours on the one hand the use of a technical ventilation system with the possibility of heating in winter, but on the other hand tries to lives without an artificial cooling or dehumidifying. This relying on technical support might be even more important if the climate at the site of your archive is either extremely hot or cold, wet or dry. So the modified thesis might be at this stage: As less technical support as possible, but as much as necessary.

The German experiences⁶ in achieving the right climatic conditions using as less as possible technical air conditioning dates back to the early 1970s when the than new building of the city archive of Cologne was erected - this building advanced quickly to the so called model of Cologne and belongs to what was described on the illustration before as “natural active climate control”. Unfortunately as you will know this building collapsed in 2009 – therefore we talk about a model without real existence any more. At the heart of this model lies the knowledge, that changes in temperature slows radically down if the building has a high thermal inertia – that was achieved by erecting the outer walls of the archive out of 49 cm of brick stones. In order to separate further the outer and the inner climate a double wall as a granite cladding was set before the brick walls. Between the brick wall and the cladding there was an air gap in which the air could circulate, this helping further to separate the outer climate from the indoor. Additionally the building had small windows so that fresh air could be taken in, when the outer climatic conditions could help to achieve the right indoor climate. Quite a few archive building in Germany, but also the Netherlands, Switzerland and Austria explicitly claimed to have followed the model of Cologne. Just to name a few:

| | |
|------|---|
| 1978 | Zwolle, Rijksarchief (NL) |
| 1980 | The Hague, Rijksarchief (NL) |
| 1985 | Zurich, Staatsarchiv (CH) |
| 1986 | Koblenz, Bundesarchiv (D) |
| 1988 | Vienna, Österreichisches Staatsarchiv (A) ⁷ |

In the year 1991 a new archive building in the northern part of Germany was erected in Schleswig – the Landesarchiv Schleswig Holstein.⁸ This claims also to stand in the tradition of the model of Cologne but goes even further in reducing active management of the climate inside. More or less the “model of Schleswig” adapts what was said before but reduces the intake of fresh air to a minimum. So no windows or air exchange facilities were build and with the use of air-locks between the storage rooms and the other parts of the building one even tried to reduce the exchange of air to the most. In buildings that use this model it is even more important to have a long period of drying after completing the building, because there is no possibility to affect the humidity

⁶ Most of the following is based on Sagstetter, Maria Rita: Klimatisierungskonzepte in jüngeren Archivgebäuden in Deutschland, in: Archivalische Zeitschrift 86 (2004), p. 323-355.

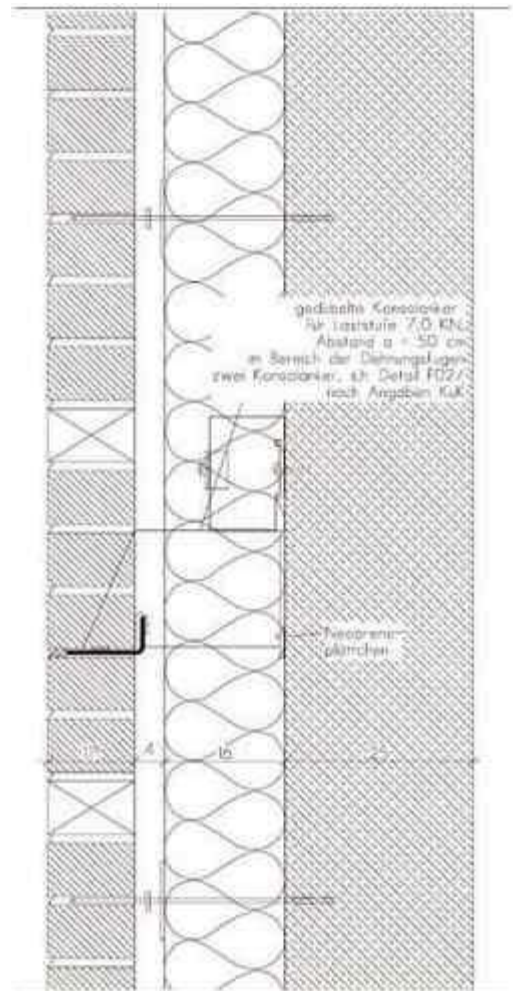
⁷ See Sagstetter, p. 333.

⁸ The concept was developed by a danish company and was laid down in Christoffersen, Lars D.: ZEPHYR Passive Climate Controlled Repositories, Lund 1995. See also Tim Padfield: The Role of Absorbent Building Material in Moderating Changes of Relative Humidity, Ph.D.thesis October 1998. <http://www.conservationphysics.org/phd/phd-indx.php> (last visited 12. july 2012)

afterwards. But of course this drying period should be considered in every new archive building. Normally one says this drying should last at least two or three winter, if there is no possibility to affect the humidity.⁹ In the following years the new buildings of the state archive of Lower Saxony in Oldenburg and state archive of Hamburg were erected using the principles of the model of Schleswig.

The new building of the Bundesarchiv in Berlin is also an adaptation of the model of Cologne. The capacity of the repository is about 125 000 linear meters of archives and books, it is five storeys high with no repository underground. It has a double wall construction consisting of a 25 cm concrete wall on the inside, 16 cm insulation, 4 cm air gap and 12 cm outside brick wall as was shown in the illustration. It has an air ventilation system and an optional air conditioning system that is planned for the public spaces but can be used for the repository as well. This air conditioning system made it possible that the Bundesarchiv moved in that building with his archives directly after the building was finished, so that no extra time for drying was necessary. It is planned to stop the usage of the air conditioning system in one or two years.

In one respect the Bundesarchiv disregarded the recommendation of DIN ISO 11799 – the maximum temperature could go up to 21⁰ C. This is due to the fact that in summer the temperature in the reading room will only be kept below 26⁰ C, and it was thought a bad idea to have a too wide gap between the temperature in the repository and in the reading room.¹⁰ At the moment the annual energy consumption for heating



Bundesarchiv Berlin: Detail section of the composite wall construction of the new repository facade - shown here is the ventilated clinker brick cladding with cavity wall insulation on a load-bearing reinforced concrete wall.

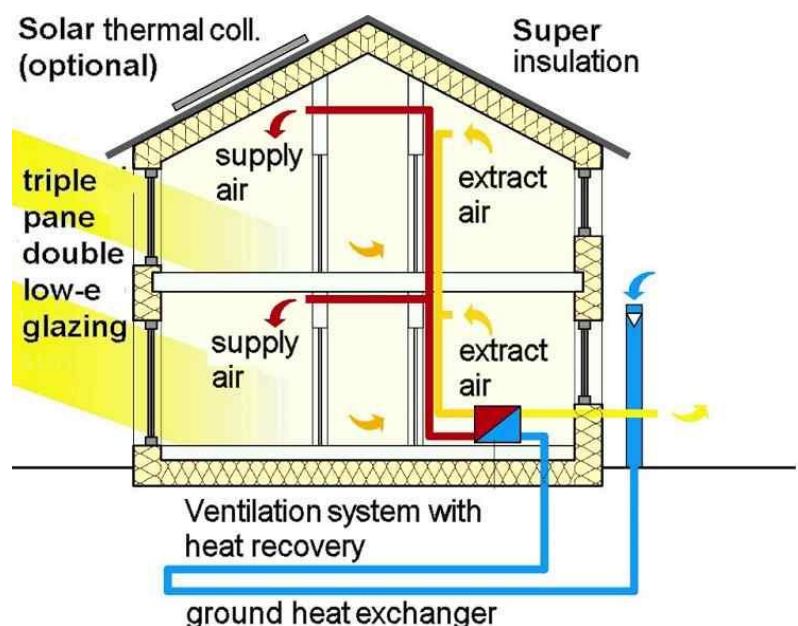
⁹ Sagstetter, p. 342f. Also Luchterhandt, Martin; Wetzel, Jürgen: Das Landesarchiv Berlin in einem neuen Gebäude, in: Der Archivar, 55, 2002, H 4, p. 306-311, here p. 308.

¹⁰ Barteleit, Sebastian: Die Baumaßnahmen des Bundesarchivs in Berlin-Lichterfelde, in: Archivar 62, 2009, H 4, p.344-350; Barteleit, Sebastian: Archibau an der Schwelle zum 21. Jahrhundert am Beispiel des Neubaus des Bundesarchivs in Berlin-Lichterfelde, in: Menne-Haritz, Angelika; Hofmann, Rainer (ed.): Archive im Kontext. Öffnen, Erhalten und Sichern von Archivgut in Zeiten des Umbruchs. Festschrift für Prof. Dr. Hartmut Weber zum 65. Geburtstag, Schriften des Bundesarchivs 72,

and cooling is about 22 kWh/m². But this should be reduced to around 11 kWh/m² when the building is completely dried and the air conditioning system is not used any more.¹¹

Another development was for a long time not connected to archive buildings – the planning of so called passive houses. The passive house standard dates back to the year 1988 when Bo Adamson of Lund University and Wolfgang Feist of the Institut für Wohnen und Umwelt Darmstadt (Institute for Housing and the Environment, Germany) laid down first principles. Eight years later in 1996 the Passivhaus-Institut was founded in Darmstadt to promote and control the standards. Of course there are other national or regional standards going in the same direction, but here the focus will be on the passive house.¹²

The basic principle of this standard is to cover the building with a superinsulation and to use a heat exchanger for bringing in fresh air. Of course this could be combined with the usage of solar thermal collectors. The passive house standard for central Europe demands that the building have to fulfil the following requirements:



http://upload.wikimedia.org/wikipedia/commons/b/bd/Passivhaus_section_en.jpg
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- The building must be designed to have an annual

demand of not more than 15 kWh/m² per year in heating and 15 kWh/m² per year cooling energy or to be designed with a peak heat load of 10W/m²

Düsseldorf 2010, p.383-392. Here you find an internet presentation to the new buildings with the illustration shown above. <http://jensites.com/bbr/site/index.php?cat=start&page=start&lang=en> (last visited, 18. July 2012)

¹¹ Internal paper: planungsteam energie + bauen: Analyse des klimatechnischen Betriebsverhaltens der Magazinräume des Bundesarchivs, 2006, p. 37.

¹² See for example the wikipedia article Passive house: http://en.wikipedia.org/wiki/Passive_house (last visited: 12. July 2012). Other national or regional standards for energy efficient houses are of course also found. See for example for the swiss standard Minergie <http://en.wikipedia.org/wiki/Minergie> (last visited, 19. July 2012), for the US Standard LEED http://en.wikipedia.org/wiki/Leadership_in_Energy_and_Environmental_Design <http://en.wikipedia.org/wiki/Minergie> (last visited, 19. July 2012) and for the Australian Standard Green Star [http://en.wikipedia.org/wiki/Green_Star_\(Australia\)](http://en.wikipedia.org/wiki/Green_Star_(Australia)) (last visited, 19. July 2012).

- Total primary energy (source energy for electricity and etc.) consumption (primary energy for heating, hot water and electricity) must not be more than 120 kWh/m² per year
- The building must not leak more air than 0.6 times the house volume per hour ($n_{50} \leq 0.6$ / hour) at 50 Pa (N/m²) as tested by a blower door.¹³

Although this standard was developed mainly for residential housings it was also realised with office buildings and the state archive of Saxony in Dresden erected in 2008 a repository building that was also certified as a passive house. This repository has a capacity of 32 000 linear meter of archives on 9 storeys, three of them underground. The archive is build using the same principles we have seen in the model of Cologne – 18 cm concrete wall, 24 cm insulation, air gap for circulation and an outer brick wall. Going beyond the model is the tested air-tightness and a cooling system using ground water. According to the passiv house standard the yearly energy consumption for heating is about 13 kWh/m² and the total primary energy need of the building – including lightning and other electrical installations is 26 kWh/m² and year.¹⁴

One step further goes the concepts of zero or plus energy houses. This sets up on tightly insulated houses and combines them with a source of energy production – normally a photovoltaic system or a block heat and power plant for the production of electricity or a solar thermal system for production of heat. The new building of the state archive of Saxony in Dresden for example has on the roof also a photovoltaic system with an installed power of 29 kWp producing in the first year 27.500 kWh.¹⁵ On one building of the Bundesarchiv in Berlin there will be such a system as well with planned 73 kWp and expected 60.000 kWh/a.¹⁶ Both archives nevertheless do not belong to the category of plus energy houses.

But even these plus energy houses do probably need some external energy input, because they are not going to use all the produced energy for its own purposes, when no power is needed the electricity will go directly into the public electricity net and on

¹³ This is taken from the wikipedia article cited above.

¹⁴ Ullrich, Anja: Der Erweiterungsbau im Passivhausstandard, in: Sächsisches Staatsarchiv Hauptstaatsarchiv Dresden. Erweiterungsbau, Umbau und Sanierung, Dresden 2011, p. 27-29. http://www.sib.sachsen.de/fileadmin/user_upload/PDF-Dokumente/broschueren/2011/2011_NL_Dresden_I_HStA_Inhalt.pdf (last visited, 17. july 2012). See also <http://www.passivhausprojekte.de/projekte.php?detail=1716> (last visited, 17. july 2012).

¹⁵ Ullrich, Anja: Erweiterungsbau, p. 29.

¹⁶ Barteleit, Sebastian: Archivbau, p. 389.

other days some extra need for electricity will be covered from the same net. But all over all the production of energy exceeds the consumption.

So in this respect the future – at least in terms of energy consumption and energy production – looks fine for the two archives, but then so far only the repositories were looked at. Unfortunately so far no archive buildings as a whole was built according to the passive house standard and it is to fear that no zero or plus energy archive exists at the moment. The discussion in Germany and Europe has focused too narrowly on the repositories and therefore energy saving in offices and reading rooms are still a thing to cope with. But then here archivists can have a look at other office buildings, and indeed the principles of the passive house are also valid for offices and reading rooms: insulation, heat exchanger for bringing in fresh air, solar thermal collectors could be used in this parts of the archive buildings as well. But one could go one step further in this parts of an archive building one probably need a good lightning – here very energy-saving lightning bulbs are available the same holds true for computer and most of the other electrical tools archives needed for their work.

So where are we at the moment and what might be a promising strategy for the future?

Lets start with a word of caution – so far all examples presented were taken from a temperate zone. What was presented seems to be working quite well for central and middle Europe. But even when looking at the model of Cologne the differences in the manner the model was interpreted at each site, has something to do with differences in the regional or local climate. Just taking the two biggest sites of the Bundesarchiv in Koblenz and in Berlin the differences are enormous: Koblenz is far more humid than Berlin and Berlin by far the extreme in winter cold and summer heat. So for each building the architects has made simulations of the changing of the indoor climate according local outdoor climate. This of course has effected the construction of the building. And what holds true for two cities in Germany that are located only 500 KM apart, of course is even more important for places in other climatic zones. Therefore one should take these examples only as a guideline and not as a model or standard. At each and every building project one should ask experts to try an adequate adaptation of one or more of the here presented principles to the need of the archive and the climate of the site.

To conclude:

1. Archive buildings in Germany and other parts of Europe are often constructed in a manner that helps reducing the energy consumption. This is certainly true for the repositories but in some cases also for other functional parts of the archives. Often this is achieved by enhancing the thermal inertia of the building by choosing rather thick walls in combination with a superinsulation and a ventilated cladding.
2. By choosing this or similar systems of air conditioning the archives are reducing the dependence from technical installations thereby gaining firstly a higher security while running the building and secondly a reduction of costs for energy.
3. Combining this with implementing facilities for producing energy – like photovoltaic systems or block heat and power plants – archive could reduce the dependence from energy prices even more. This will be even more interesting in the future since it is very probable that prices for these facilities will decrease rapidly, while energy prices tend to rise.
4. And last but not least – always remember that an archive is more than its repositories. Energy consumption in reading rooms and office areas are contributing a serious part of the costs for energy. Partly the same principles could be applied as for the repositories but going beyond that one should have a look at modern office buildings and new developments in energy-saving equipment.