THE NUBIAN VAULT

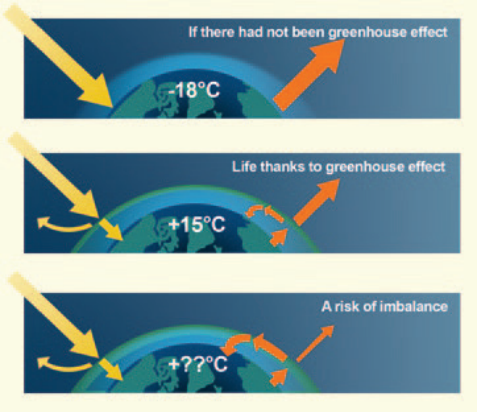
A Low-Carbon Housing Solution for Adaptation and Mitigation of Climate Change

A ROOF, A SKILL, A MARKET
The Nubian Vault

CLIMATE CHANGE

Due to greenhouse gas emissions linked to human activities (deforestation, industry, agriculture, residential, commercial and public buildings, electricity production, transport, waste), climate change can already be observed and will increase in the future:

- **rising global temperatures, disruption of seasonal rain cycles, etc.**



In order to limit these devastating and irreversible impacts, the increase in global temperatures needs to be limited to +2°C (*).

For this, it is essential to reduce our CO_2 emissions by 50% by the year 2050 and 90% by the year 2100.

Greenhouse effect: a phenomenon unbalanced by Man © ADEME

HOUSING, A MAJOR ISSUE

In the Sahelo-Sudanian area, millions of families lack access to decent housing because of the disappearance (through deforestation and desertification) of natural ligneous resources used in traditional architecture, as well as demographic and economic realities, and urban growth.

«Modern» technical alternatives have not enabled the greatest number of people to access appropriate and sustainable housing.
They require highly inappropriate materials (cement, iron steel, sawn timber etc.) and do not fit into local economies (imported construction materials,

(*) According to the Intergovernmental Panel on Climate Change

DEMOGRAPHY AND ACCESS TO BASIC SERVICES

In 2010, the global construction industry was responsible for 19% of greenhouse gas emissions linked to energy use.

This energy consumption and its associated emissions are expected to double and even triple by 2050, due in particular to a critical trend:
the need for millions in developing countries to access appropriate housing, electricity and improved cooking equipment.[1]

In the Sahelo-Sudanian area, this trend will be widely magnified by demographics: its population is estimated to grow from 250 million inhabitants in 2013 **to 650 millions in 2050.[2]**

It is therefore urgent to adopt housing solutions that are durable, low-carbon and permit a real mitigation of, and adaptation to, climate change.

1 - Source : Climate Change 2014, Mitigation of Climate Change, IPCC Working Group III Fifth Assessment Report, chapter 9 Building, pp 675 and 679.
2 - based on the World Population Prospects, United Nations, 2013 (Medium Variant) and the geographical delimitation of the Sahelo-Sudanian strip.

THE NUBIAN VAULT TECHNIQUE: AN APPROPRIATE HOUSING SOLUTION

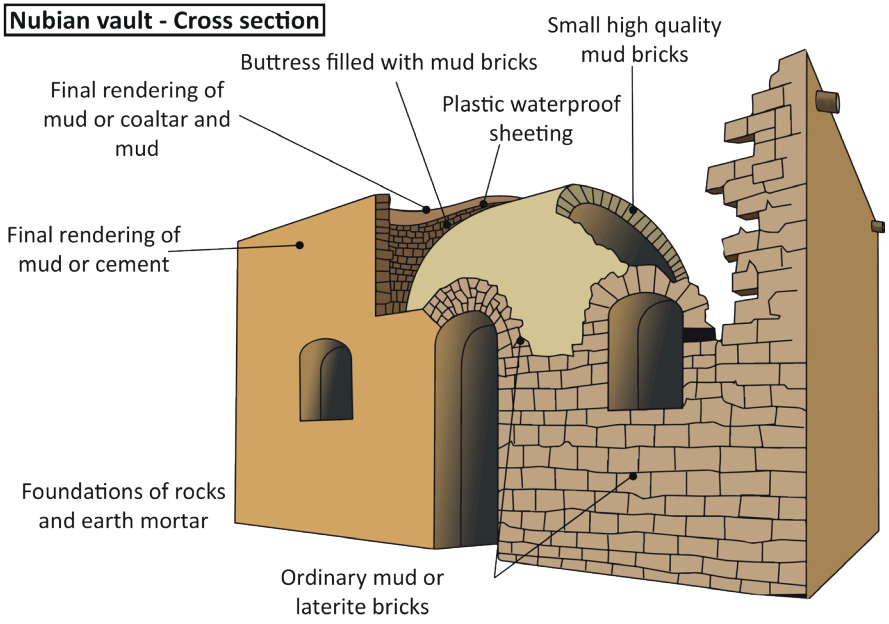
The Nubian Vault is an **age-old architectural technique** originating in Upper Egypt and historically unknown in other African regions.

This technique involves the construction, with basic tools, local materials and simple skills, of modern, solid, **comfortable and modular buildings with vaulted roofs.**

Its specificity is marked by:

- the use of raw earth, a widely available raw material, to make mortar and sun-dried bricks,
- the lack of a timber framework for construction of the vault.

The inertia of the Nubian Vault structure (created by the substantial thickness of the raw earth walls) entails a significant alleviation of temperature changes inside the building.



CLIENTS' TESTIMONIES

Testimonies collected in 2015 among the 1,500 clients who have constructed a Nubian Vault since 2000 in over 700 towns in Western Africa (in Burkina Faso, Mali, Senegal, Benin, Ghana, and Mauritania).

« In that season, it's cold outside, but in these rooms the climate is good. We spend the night under metal roofs, but we are always cold. But here, we feel good, that's why all the children come here to spend the night. »

Malick SY, Nubian Vault client in 2012, Diatar, Senegal

« That house, it's a good house. If you've built that house, you don't need any more wood, you don't need anymore metal sheets, nothing. When it rains, it isn't like metal sheet. When it rains, if you're sleeping even, you go out in the morning, you see the water in the courtyard, you didn't even know there was rain in the night. With metal sheets, it makes a lot of noise, you can't even sleep. ».

Ebou KANKOU, Nubian Vault client in 2006, Boromo, Burkina Faso

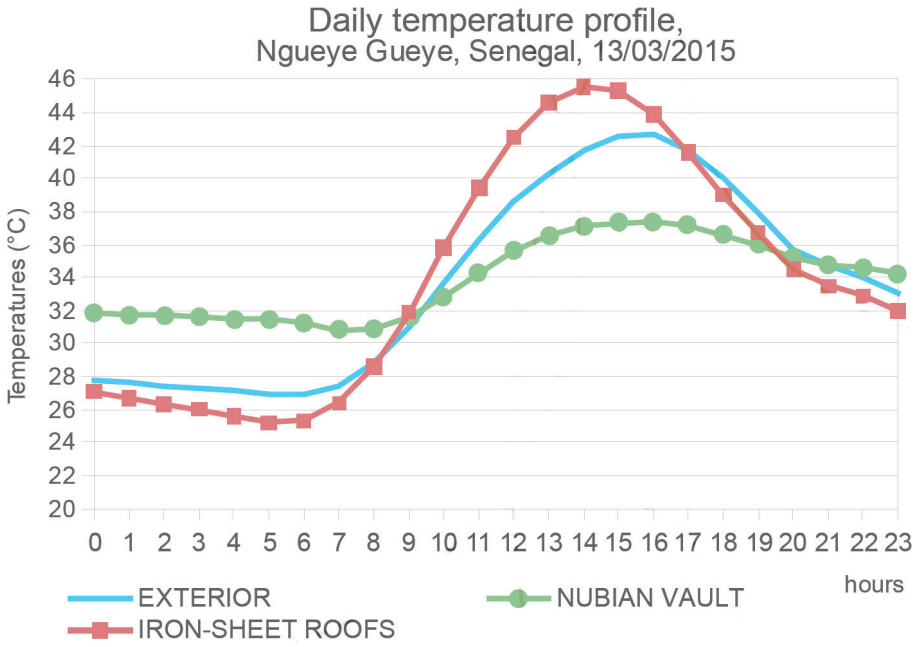
« For sustainability, the Nubian Vault is better than the other constructions. For comfort, warmth or coolness, we feel that it can increase the life expectancy of the elderly. »

Michel DIOUF, Nubian Vault client in 2015, Ngueye Gueye, Senegal

« The Nubian Vault is good for one's health, you think there is air-conditioning in the room, it's cooler. »

René NDONG and Brigitte PHIAW, Nubian Vault clients in 2014, Ngueye Gueye, Senegal

THERMAL COMFORT



There have been a number of comparative thermal measurement studies led in Burkina Faso and Senegal since 2007, and they confirm **the significant increase in thermal comfort felt by the Nubian Vault clients.**

Cold discomfort (temperatures < 20°C) is very low or nonexistent.

Very hot discomfort (temperatures > 37°C) is significantly reduced compared to a corrugated roof house.

Nubian Vault structures also bring:

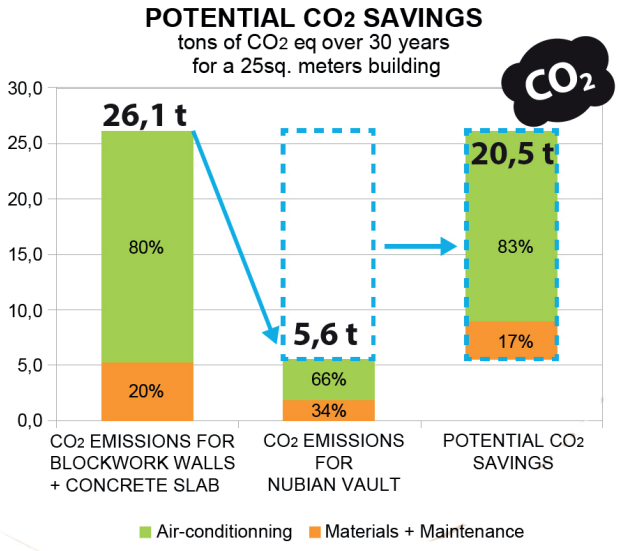
- **considerable acoustic comfort during rain**
- **an efficient protection in adverse weather, strong winds in particular.**

GREENHOUSE GAS BALANCE

Quantification of greenhouse gas emissions during the building lifecycle (basic materials, construction, transportation, usage) calculated over 30 years (*).

For a 25 m² house, greenhouse gas emission gains are **20.5 tons of carbon equivalent**, compared to a cement block building with a concrete roof, which would provide the same usage levels (viability of the structure, thermal and acoustic comfort, weather protection):

- **3.4 tons of carbon equivalent saved during the construction and maintenance phase** thanks to the use of very low environmental impact materials (raw earth).
- **Up to 17.1 tons of carbon equivalent can be saved during the airconditioning phase** to reach an acceptable level of thermal comfort (< 32°C).



(*) Average potential CO_2 savings calculated, subject to change depending on the size of the buildings, the site of construction and the climate, according to « Etude portant sur la technologie Voûte Nubienne comme mode le de construction, rapport final » (2015).

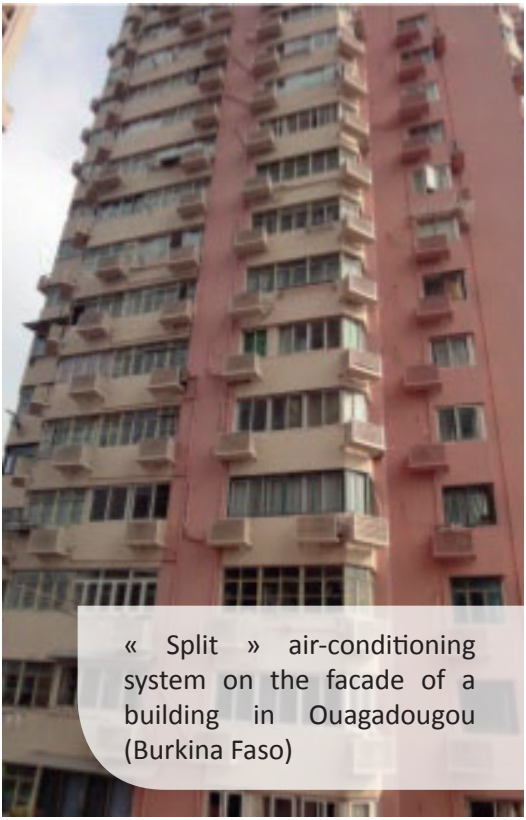
LOW CARBON HOUSING, ADAPTED TO CLIMATE CHANGE FOR AS MANY PEOPLE AS POSSIBLE

The use of raw earth, a readily available local material with an exceptional ecological performance, plus the NV architectural technique allows for:

- **the re-appropriation of an « archiculture » and traditional know-how,**
- **a significant reduction in carbon emissions associated with construction,**
- **thermal and acoustic comfort which significantly increases the beneficiaries' quality of life.**

▶ thus increasing the capacity for resilience of Sahelo-Sudanian populations, among the most vulnerable to the impacts of climate change

Energies House, Matam region, Senegal, 2011



« Split » air-conditioning system on the facade of a building in Ouagadougou (Burkina Faso)

Air-conditioning for all will not be possible!

Already today, electricity production and distribution infrastructures struggle to meet the current demand; the rise in average temperatures and demographic growth oblige African politicians to find means to anticipate and reduce this popular demand while still supporting the increase in standards of living.

NV constructions are an appropriate answer to these issues: the Nubian Vault's passive energetic performance reduces energy consumption for air-conditioning and ventilation,

▶ **thus reducing future demands for electricity**

THE NUBIAN VAULT, A SOLUTION FOR ADAPTATION AND MITIGATION OF CLIMATE CHANGE

The large-scale dissemination of the Nubian Vault technique (market growth > 25%) over the entire Sahelo-Sudanian strip **would provide millions of people with access to sustainable and comfortable housing adapted to climate change.**

This adaptation would be accompanied by a **significant diminution of greenhouse gas emissions linked to the construction industry**, at around 45 million tons of carbon equivalent by 2040 along with **numerous other benefits:**

- **cultural (use of local and appropriate technologies),**
- **economic (hundred of thousands of green jobs created),**
- **technological (control over the demand for energy),**
- **environmental (preservation of ligneous resources).**

According to the following scientific and technical studies:
- Rapport technique «Indicateurs de confort dans la technique de la Voûte Nubienne», Wyss Urs, Ing. Civil Dipl. EPFL, Sauret Hugues, Ing. énérg., ENERSOL-A, 2007
- Streamlined Carbon Footprint - AVN, Environmental Ressources Management, ERM, 2010
- Impact of Climate Change and Energy Saving in Buildings for Burkina Faso, Bachir Ismael Ouedraogo, 3rd year PhD School of Mechanical, Aerospace and Civil Engeneering, 2011
- Confort thermique des bâtiments en voûte nubienne, Madiana HAZOUME, Mastère Spécialisé - EINTE ICAM Nantes, 2013
- « Promotion des pratiques de Gestion Durable des Terres pour restaurer et améliorer les stocks de carbone grâceà l'adoption d'initiatives d'habitat vert en milieu rural: Étude portant sur la technologie Voûte Nubienne comme modèle de construction », Bruno JARNO pour, Ministère de l'Environnement et du Développement Durable, République du Sénégal, 2015
-Instrumentation thermique comparative de bâtiments de conservation de l'oignon, groupe GCIUS, Université de Sherbrooke, En cours.

The Nubian Vault, an innovative program...
... encouraged by political actors,

« It is the living and housing standards that contribute the most to the health and well-being of the populations. The Nubian Vault should be supported by the Ministry for Environment and Sustainable Development because it corresponds exactly to our policy for resource management and the fight against poverty. »

Abdoulaye BALDE, Minister of Environment and Sustainable Development of Senegal, testimony received in Dakar, January 2015

... supported by many financial partners,

AFD Agence Française de Développement

Autodesk Foundation

Fondation Eiffage

YCID Yvelines Cooperation Internationale & développement

Alwaleed Philanthropies الوليد للإنسانية

Dubai Charity Association جمعية دبي الخيرية

Projet soutenu par Fondation de France

Agence de l'Environnement et du Développement Durable AEDD

UN-Habitat

AFID Uniting against Poverty

...recognized by numerous international awards, especially concerning the environment and sustainable development.

changemakers Affordable Housing 2006

Momentum for Change UNFCCC

Schwab Foundation for Social Entrepreneurship 2012

Dubai International Award for a Better Urban Future UN-Habitat 2013

2012 - 2014 Semi Finalist The Buckminster Fuller Challenge 2015 Finalist

Aga Khan Award for Architecture 2007 & 2010 Nominated

Eco SXSW 2016 Finalist

my positive impact Laureat

The Tech Awards 2007

world habitat awards 2009 - 2016 Finalist

Social Innovation Awards 2016

Forum Afrique 100 Innovations pour un développement durable 2013

2009 Grant Competition Climate Adaptation

A ROOF, A SKILL, A MARKET

The Nubian Vault

AVN France
contact@lavoutenubienne.org

AVN Senegal
avn-senegal@lavoutenubienne.org

AVN Burkina Faso
avn-bf@lavoutenubienne.org

AVN Benin
avn-benin@lavoutenubienne.org

AVN Mali
avn-mali@lavoutenubienne.org

AVN Ghana
avn-ghana@lavoutenubienne.org

FOLLOW US ON:

www.lavoutenubienne.org/en

thenubianvault @earthroofs