



Africa-Europe BioClimatic buildings for XXI century

**POLICIES SUPPORTING PASSIVE AND
BIOCLIMATIC APPROACHES AND THE
DEVELOPMENT OF LOCAL MATERIALS
IN NW-AFRICA & EU**



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ABC 21 Project

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Executive Summary

We review in this report some successful or promising policies which might be effective in promoting highly comfortable buildings with minimal energy need for heating and cooling¹, total primary energy use, and non-renewable energy use, with a particular focus on summer comfort and cooling dominated climates. At the same time, we consider also policies and institutional frameworks for the promotion of the use of local, low impact materials. The focus of the analysis is methodological: **the aim is to highlight some key points which might be useful in developing or assessing policies.**

Some national implementations of the European Energy Performance of Buildings Directive (EPBD) are analyzed according to a set of criteria, e.g. :

- **Uniformity in definition** of overall building energy performance, to be expressed in terms of energy needs, delivered energy, total or non-renewable primary energy, as univocally defined in EN-ISO 52000 – 2017.
- **Explicit choice of a comfort model** which might favor the use of the bioclimatic approach, with reference to the most recent standards e.g. ASHRAE 55-2020.
- **Use of physical energy balance** rather than a nominal net-zero balance over a year.

Europe (as the rest of Global North) has developed building archetypes relying heavily on materials of high embodied energy (concrete, steel, glass) and raw materials which are getting scarce. We review some experience and policies applied in Africa for qualifying and supporting bio- and geo- locally sourced materials.

For both continents, policies to support bioclimatic architecture under the XXI Century conditions will likely have to go beyond the building itself and involve district and city levels. Within the future climate, which will bring longer and longer periods of high temperature in summer, exacerbating the heat island effect in cities, efficient design and operation of buildings will be strongly connected with enabling/hindering conditions in cities. We present a matrix of interaction of policies aimed respectively at building and district level with a view of highlighting the necessary synergies.

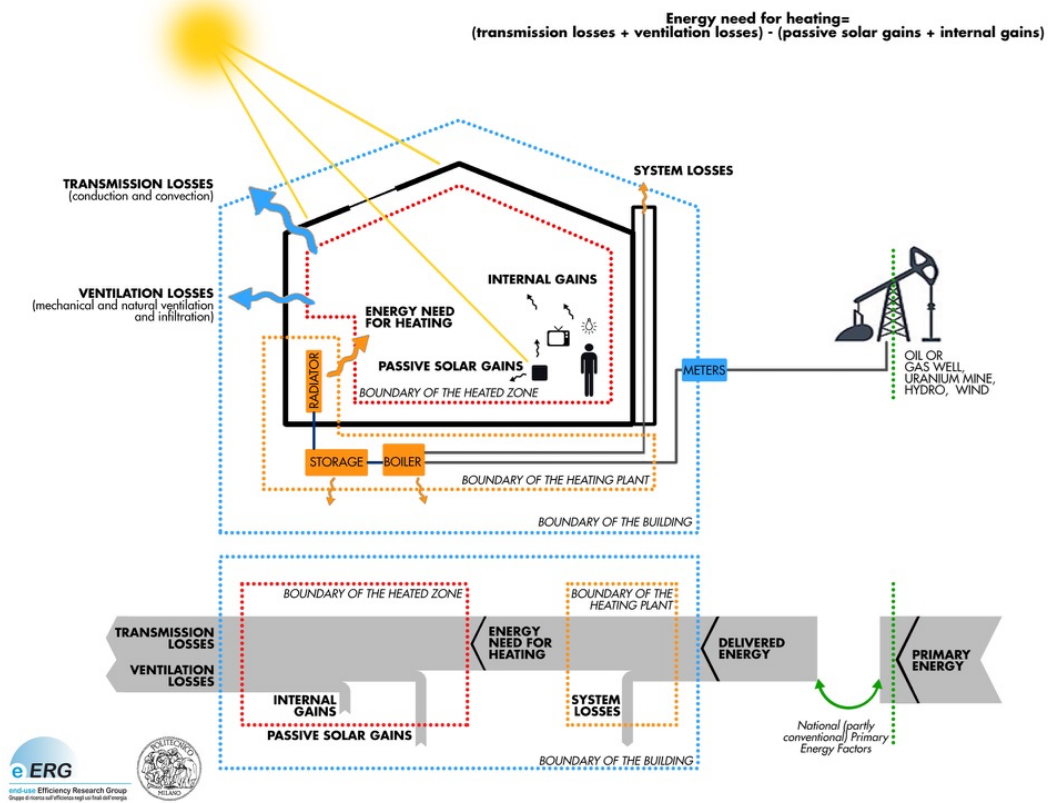
We also briefly discuss the importance of complementing bioclimatic architecture with clean cooking technologies with the double objective of lowering energy use and improving Indoor Air Quality (IAQ).

As for financing economic incentives and support programmes, the report discusses:

- **ways to finance:** via debt or general taxation versus via a levy on energy carriers, with their respective implications on state budget and stability of industrial policy over time
- **ways to establish a priority of investments** with a focus on short term (indicators as Payback-time, marginal cost, interest rate from the private perspective...) or on

¹ For the definitions of energy needs, delivered energy, total or non-renewable primary energy, see D2.1. Explicit Correct defin

reduction of risks and reduction of long term costs (full consideration of environmental and social externalities, internal rate of return, cost of conserved energy, interest rate from a societal perspective...)



Abbreviations

Term	Name
AFMIN	Africa Microfinance Network
AR5	IPCC's Fifth Assessment Report
AR6	IPCC's Sixth Assessment Report
CEBs	Compressed Earth Blocks
CH4	Methane
CO₂	Carbon Dioxide
Dx.x	Deliverable
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EPBD	European Energy Performance of Buildings Directive
ESCOs	Energy service companies
EU	European Union
IAQ	Indoor Air Quality
ICTs	Information and Communication Technologies
IPCC	Intergovernmental Panel on Climate Change
LEED	Leadership in Energy and Environmental Design
N₂O	Nitrous oxide
NSB	National Standards Bodies
N-W	North-West
nZEB	nearly Zero Energy Building
NZEB	Net Zero Energy Buildings
OECD	Organization for Economic Co-operation and Development
PED	Positive Energy District
RES	Renewable Energy Sources
SDG	Sustainable Development Goals
TEE	Titoli di Efficienza Energetica

INTRODUCTION	8
1.1 Scope and objectives	9
Background & objectives	11
2.1 Supporting policies for Bioclimatic and passive approach	12
Building level	12
District/urban level	12
2. POLICY FRAMEWORK IN THE EU AS EXAMPLE OF POLICIES FOR LOW ENERGY USE IN OPERATIONAL PHASE	15
3.1 Standards on comfort and energy performance	15
3.2 Energy performance of buildings (EPBD) and a distinction between: nearly Zero Energy Building (nZEB) and Net Zero Energy Buildings (NZEB)	16
3.3 An example of national implementation of EPBD, with potentialities and limits	17
Italian implementation of EPBD an nZEB definition	17
Comments and potential improvements	20
3. REGULATION FOR PROMOTION OF LOCAL BIO & GEO SOURCED MATERIALS WITH LOW EMBEDDED ENERGY	21
4.1 Earth standards	21
4.2 Straw Bales standards	23
4.3 Research activities and promotion	23
4. CLEAN COOKING AS A COMPLEMENT TO BIOCLIMATIC ARCHITECTURE FOR LOWERING ENERGY USE AND IMPROVING IAQ	25
Moroccan test for preparation of tagine in electric pressure cookers	25
Potential improvemenst to injera baking in Ethiopia	26
5. FINANCING: CREDIT AND MICRO-CREDIT	27
FINANCING: STATE INCENTIVES OR DIRECT INVESTMENTS, AND THE COLLECTION OF RESOURCES	28
REFERENCES	33

Figures

Figure 1: Project and reference building [34].	18
Figure 2 Compressive strength experimental testing set up [37].	24
Figure 3. Various cooking techniques.	25

Figure 4. Injera being cooked on a griddle. The bottom surface of the injera, which touches the heating surface, has a relatively smooth texture, while the top is porous. This porous texture makes injera good for scooping up sauces and dishes. Source: <https://en.wikipedia.org/wiki/Injera> 27

Figure 5. An electric stove for baking injera. Source: <https://en.wikipedia.org/wiki/Injera>..... 27

Figure 6: top line: marginal price for the consumer (price of the last unit bought) grows with the number of units used over a certain billing period. The price paid can be distributed among the supplier (distribution or supply company), a fund to finance energy efficiency programmes (CCSE) and the State as e.g a Value Added Tax 31

Tables

Table 1. Interactions between policies to support reductions in energy use at building and district/city level. Both types of policies might concur to support the uptake of the bio-climatic approach Source: [1] 14

Table 2: Requirements for nZEB buildings according to Italian legislation (DM 26/06/2015 and DLgs 03/03/2011). 18

Table 3: Countries with already established building standards and codes for earth and ecological buildings with their respective standard type. 21

Table 4: Brick classes for earth blocks (EB) following DIN EN ISO 7500-1:2004-11. 22

Table 5: Brick classes for earth masonry mortar (EMM) following DIN EN 1015-11: 2007-05. 22

Table 6: Brick classes for earth plaster mortar (EPM) following DIN EN 1015-11: 2007-05..... 22

Table 7: Area of applications of earth building materials as a function of their strength following DIN 18945-48. 23

Introduction

We review in this report some successful or promising policies which might be effective in promoting highly comfortable buildings with minimal energy need for heating and cooling, total primary energy use, and non-renewable energy use, with a particular focus on summer comfort and cooling dominated climates. At the same time, we consider also policies and institutional frameworks for the promotion of the use of local, low impact materials. We finally mention the importance of complementing bioclimatic architecture with clean cooking technologies with the double objective of lowering energy use and improving IAQ.

The focus of the analysis is methodological: the aim is to highlight some key points which might be useful in developing or assessing policies.

EU has created via its Directives a legislative infrastructure (mandatory building performance certificates, cost optimal methodology, mandatory nearly Zero Energy Buildings, National renovation plans) and support actions (e.g. Framework Research Program, H2020, fiscal policies and incentives to energy efficiency in many states, ...).

Voluntary labels like Minergie and Passivhaus, CasaClima, in certain cases used by local governments as *de facto* standards, have favored innovation and high-quality materials and components.

But also important limitations have been created by a nonuniformity of nomenclature among Member States, and the parallel nonuniformity in definition of overall building performance when expressed in terms of energy needs, delivered energy, total or non-renewable primary energy [1], as univocally defined in EN-ISO 52000 – 2017 [2].

This creates a barrier to effective communication and comparability of performances of design approaches and techniques. Other approaches have taken more the road of giving the building sector precise guidance on the performance of single elements, with a clear focus on the envelope, as e.g. the obligations on g-value of solar protections and on thermal mass in Switzerland.

Some of the lessons learned from the application over time of the above policy tools will be relevant in a different context where there is high pressure from the need for affordable new housing e.g. in N-W Africa, and hence a need to promote good buildings from the start, in order to avoid to lock-in in a state of high energy demand the building stock. Africa might avoid the process whereas e.g. in Europe, very low-quality envelopes were built over decades of apparent infinite availability of cheap fossil energy, thus resulting in the present need to invest large amounts of resources and time to retrofit the large inefficient building stock thus created.

Africa could leap-frog and construct from the start building fabrics that have very low energy needs for heating and cooling, and hence can be served in an affordable way by limited amounts of renewable energy.

On the other side Europe has developed an architecture relying heavily on materials of high embodied energy (concrete, steel, glass) and raw materials which are getting scarce. It becomes urgent to explore how policy initiatives may promote geo and bio sourced materials in Europe, possibly taking inspiration of experiences in Africa, in particular in the N-W.

For both continents, policies to support bioclimatic architecture under the XXI Century conditions will likely have to go beyond the building itself and involve district and city levels.

Within the future climate, which will bring longer and longer periods of high temperature in summer, exacerbating the heat island effect in cities, efficient design and operation of buildings will be strongly connected with enabling/hindering conditions in cities. E.g. the use of night ventilation of a residential building in summer to achieve comfort without (or with limited) use of air-conditioning are dependent from the level of noise and air pollution in the surrounding area, on the use of cool materials for urban surfaces, on shading and presence of vegetation at district level.

Hence, legislation and policies able to guide land planning procedures in a direction favorable to bioclimatic architecture are relevant for the future. Policies for mobility in a situation of rapid urbanization as in many African countries might profit of EU experience and jump forward with creativity by avoiding the car-centric design which many EU cities are now committing to reverse, in certain cases with rapid results (e.g. Paris, Bruxelles...). Indicators of “*accessibility*” rather than “*mobility*” should be used to drive the planning process in a more sustainable direction, as suggested e.g. in a major study for OECD. [3]

1.1 Scope and objectives

Based on the analysis performed in the parallel work for preparation of D3.1 (energy indicators) and D3.2 (comfort indicators), which has shown the recent progress in the definition of low and zero energy buildings and the development of comfort models, a series of criteria are derived for the analysis of current policies and the formulation of forward-looking ones. For a summary of D3.1 (energy) and D3.2 (comfort), see the deliverables themselves and the presentation of the keypoints in the webinar (Energy and comfort assessment in buildings: important new advances introduced in international standards. Which implications arise for EU and African policies?) held at eceee conference and available [online](#). Those criteria might be summarized, for clarity of presentation and communication in the form of a list of questions:

- Do policies **EXPLICITLY** mandate reductions of “energy needs for heating and cooling”?
- Do policies promote reduction of total primary energy use and not only of non-renewable primary energy use, do they promote low and zero energy balance with a physical rather than fictional accounting approach?
- Do policies explicitly refer to the Adaptive Comfort model?
- Do policies allow and promote use of air velocity as key factor for summer comfort?
- Do policies correctly consider both stationary parameters (e.g. stationary thermal transmittance) and dynamic parameters (e.g. periodic thermal transmittance, phase shift and attenuation of heat wave through walls and roofs)?
- Do policies promote physical and regulatory frameworks that enable low-energy lifestyles (i.e. sufficiency, as defined in IPCC Sixth Assessment Report Chapter 5 on energy demand)?
- Do policies promote clean, silent, low temperature districts where to build?
- Do policies support a “societal point of view” in investment analysis? e.g. using “cost of conserved energy” or Internal rate of return rather than (short time oriented) payback time as indicator? Are policies based on societal discount rates (e.g. 1-2%) rather than private discount rates (e.g. 5-10%)?

- Do policies include external costs (pollution, health damage) in calculating the optimal level of energy needs or energy performance of buildings to be enforced?
- Do policies support the conscious and skilled use of local materials and their integration in the design and construction workflow?
- In general, do policies support the adoption of bio-climatic approach and passive techniques in general terms or via precise, verifiable approaches and parameters as e.g. the above-mentioned ones?

Background & objectives

The recent IPCC's Sixth Assessment Report (AR6) on the physical science basis of climate change concludes that

“It is unequivocal that human influence has warmed the atmosphere, ocean and land. Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred.

Since 2011 (measurements reported in AR5), concentrations have continued to increase in the atmosphere, reaching annual averages of 410 ppm for carbon dioxide (CO₂), 1866 ppb for methane (CH₄), and 332 ppb for nitrous oxide (N₂O) in 2019.... The scale of recent changes across the climate system as a whole and the present state of many aspects of the climate system are unprecedented over many centuries to many thousands of years. ... In 2019, atmospheric CO₂ concentrations were higher than at any time in at least 2 million years (high confidence), and concentrations of CH₄ and N₂O were higher than at any time in at least 800,000 years (very high confidence).

Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5. “

Under such dramatically shifting boundary conditions, policies should evolve creatively and as quickly as possible. In particular, countries under strong and rapid evolution might profit of previous experience (positive and negative) to leapfrog towards new policies able to strongly participate to mitigation of climate change at global level and to embed the adaptation to future climate needed at local level.

Currently energy efficiency and, more recently, energy flexibility drive the policy practices to achieve high sustainability goals, e.g., in a heating dominated period a clever utilization of thermal mass may allow one to manage the building as a thermal battery over a time frame of a few days rather than hours, if the building fabric is highly insulated and high efficiency heat recovery on ventilation is applied. Similarly, in a cooling dominated period of the year or in a cooling dominated region, as many in Africa, thermal mass, heat protection, adequate and accurately controlled ventilation openings and other passive techniques may allow to manage the building as a thermal battery over a time frame of a few days rather than hours.

Therefore, in the case of existing buildings, the path of deep renovation focused first at improving the building fabric, can be a prerequisite enabler. This flexibility (in new or retrofitted building fabrics) allows dealing with the challenges linked to the intermittent nature of many renewable energy sources and their exploitation at the level of a cluster of buildings. Given the need of a means of storage from the daily to the interseasonal scale, a strong reduction of energy needs for heating and cooling via efficiency techniques and physical and regulatory frameworks that enable low-energy life-styles might prove decisive. This would reduce the size of the required storage and the connected embedded energy and energy losses.

At the same time, a strong reduction of energy needs and hence of the physical infrastructures required to serve those needs, appears as a fundamental step for achieving the international goals related to halting land consumption. The United Nations Sustainable Development Goal (SDG) indicator 11.3.1: “Ratio of land consumption rate to population

growth rate” observes that when this ratio is high, such a “growth turns out to violate every premise of sustainability that an urban area could be judged by”.

In Europe, where population is projected to remain stable or even slightly declining throughout this century [4], the EU institutions have taken a commitment to be “a frontrunner in implementing [. . .] the SDGs” and to aim at “no net land take by 2050” [5,6]. On 29 April 2021 the European Parliament approved with a majority of 605/660 a resolution asking the EU Commission to draft a new directive for the protection of soil with the objectives of “no land degradation” by 2030 and “*no net land take*” by 2050 at the latest. The inclusion of **land protection objectives** might be quite important also for Africa, to face climate instabilities affecting food production and the doubling of population foreseen in the next few decades.

2.1 Supporting policies for Bioclimatic and passive approach

Building level

Bioclimatic approach with its reliance on passive technologies is by definition a solution to the goal of mitigation (by minimizing use of active systems requiring an external – mostly fossil in last century – source of energy) and the need for some adaptation (by creating indoor and outdoor spaces which provide comfort just with passive interaction with the surrounding environment).

Recently the concept of “*passive survivability*” by the LEED certification framework rephrases what has been the objective of vernacular architecture for centuries and was made explicit and conscious by the work of bio-climatic researchers and pioneers of XX century (Baruch Givoni, Victor Olgyay, Laurie Bake, Assan Fathy...)

Use of local materials with low embedded energy and little environmental impact has also been a necessity for centuries and after being abandoned is making a comeback at many levels, including high quality, conscious architecture as e.g. Anupama Kundoo, Francis Kéré, Mass group are practicing. Those approaches have the potential to overcome the aura of modernity constructed around standardized and architecturally poor construction typologies which became prevalent in the OECD countries during the last decades of XX century and are now often used as models in developing and emerging countries.

District/urban level

The cultural shift needs to be appreciated and incorporated in policies not only at building level, but also at district/urban level. This is part of the philosophy and physics of bio-climatic architecture and was made explicit since the beginning e.g. in the seminal work of Baruch Givoni [7] [8], Hassan Fathy [9], Louis Soulier [10],...

The challenge of sustainable development of urban areas is of key importance for both Africa and EU. The European Union has defined ambitious strategy and implementation plans to make cities inclusive, safe, resilient and sustainable, in accordance with the 2030 Agenda for Sustainable Development of the United Nations [11]. Ongoing and foreseen accelerated urbanization in many areas of the world, including Africa, interacts with other challenges, including rapid population growth, age structure of population, climate change, environmental quality and access to energy [12]. Urban and regional planning is called to reassess how to sustainably supply the population with the needed services at an affordable cost. Reflecting

this, urban actors and scholars have created a number of city labels, such as “sustainable city”, “smart city”, “green city” and “resilient city”, to represent cities’ responses to various challenges of urban transformation. Among them, the ‘smart city’ has prevailed as the most researched concept in the recent period [13], even if it is sometimes presented as being focused only on the application of information and communication technologies (ICTs) and leaving in the background a number of issues related to building physics and space and social organization. Most recently a “15 min City” concept has been presented that proposes fundamental changes in urban planning aimed at redesigning neighborhoods so that individuals can reach the school, workplace, groceries, sport and recreational sites, etc., within a 15 min travel distance, either by bike or on foot [14,15].

Sufficiency Actions in Buildings→	Summer Night Ventilation and Ceiling Fans Rather Than Air Conditioning	Summer Night Ventilation Rather Than Air Conditioning	Adequate m ² per Capita Floor Space	Adopt “Sufficient” Mobility Modes: Bicycle, Walk, Public Transport	Line Drying and Water/Hot Water Saving
In order to perform sufficiency actions, inhabitants would need→	Silence at night, clean air	External air temperature < 20 °C at night	Pleasant common indoor/outdoor spaces (shared guest rooms, music rooms, office space, playing spaces for children, etc.) to reduce the need for individual volumes	Easy access to services, schools, work and coworking spaces, equally distributed in the city; independence of movement for children and elders	Well-designed spaces for line-drying, installed water saving devices. Comfortable showers in place of bathtubs
Presently cities create constraints→	Noise, mainly from cars and motorcycles. PM10, PM2.5 pollution and other air contaminants	Asphalt, city canyons	Inhospitable districts, obligation for car parking spaces at buildings and free car parking on streets	Distance between functions, unacceptable risks for cyclists, pedestrians and persons with disabilities	Dust in air
Cities should offer enabling conditions→	Car-free residential districts and zones at 20 or 30 km/h	White/cool surfaces. Geometries facilitating air movement. Water surfaces and urban vegetation	Walkable, cyclable districts, green spaces, spaces for playing and spaces in the building for common activities	Equitable access to street space and equal access to various transportation modes	Information campaigns on water saving devices and on the high quality of drinking water from the tap
Legislation and Regulation should address→	Objective and adequate temperature and humidity set-points in regulation. Limitations to car number and to speed limits to 20–30 km/h	Mandatory white/cool surfaces, mandatory external solar protections (as, e.g., in Switzerland)	Minimum requirements of green spaces and of common spaces for meetings	EPBD (and national build codes): mandatory protected spaces inside buildings for bicycles, wheelchairs and strollers	Mandatory spaces for line drying, mandatory labeling of low-flow water devices, mandatory showers rather or in addition to bathtubs (with access at the same level of the floor for easy access by aging population)

Table 1. Interactions between policies to support reductions in energy use at building and district/city level. Both types of policies might concur to support the uptake of the bio-climatic approach Source: [1]

2. Policy framework in the EU as example of Policies for low energy use in operational phase

In the Commission work programme for 2021, the revisions and initiatives linked to the European Green Deal climate actions and in particular the climate target plan's 55 % net reduction target are presented under the Fit for 55 package.

The European Green Deal, presented in the communication (COM(2019)640) of 11 December 2019, sets out a detailed vision to make Europe a climate-neutral continent by 2050, safeguard biodiversity, establish a circular economy and eliminate pollution.

In her 17 September 2020 State of the Union address, the Commission President Ursula von der Leyen proposed the emissions reduction target for 2030 to be set at 55 %, alongside a revision of the EU's climate and energy legislation by June 2021, a target of spending 37 % of the €750 billion NextGenerationEU recovery fund on Green Deal objectives, and the intention to raise 30 % of the NextGenerationEU budget through green bonds.

The Commission adopted the communication 'Stepping up Europe's 2030 climate ambition - Investing in a climate-neutral future for the benefit of our people' (commonly known as the 2030 EU Climate target plan), on the same day. It also includes an updated 2030 emissions reduction target of net 55 % compared to 1990 levels, from the current 40 % emissions reduction target.

Revisions of all the main Directives addressing energy (Energy Performance of Building Directive, Energy Efficiency Directive, Renewables Directive) are underway and foreseen to be completed within 2023.

Connections between buildings and mobility (hence districts/cities) have appeared for the first time in the 2017 version of the EPBD, where art 8 and recital 28 ask for holistic urban planning, creation of spaces for bikes in buildings, ... and has been clarified/reinforced in text of the upcoming revision, also under pressure by environmental groups (e.g. European Cycling Federation), making mandatory the creation of at least two bike spaces for every apartment or housing unit.

At the same time at EU level, work is ongoing to develop a framework definition of Positive Energy District (PED) and Key Performance Indicators for measurable PED comparison, that can support the development of 100 PEDs by 2025 and beyond; a plan for 100 climate-neutral EU cities by 2030 is also being developed.

3.1 Standards on comfort and energy performance

Thermal comfort analyses have inspired the development of several models in the last fifty years [16,17]. The most adopted thermal comfort models are the so-called rational comfort model developed by Fanger [18], the ASHRAE adaptive comfort model developed by de Dear and Brager [19,20] and the European adaptive comfort model developed by Nicol and Humphreys [21]. Fanger's thermal comfort model, often referred to as the PMV/PPD model, was built on experiments involving exposure of subjects to steady-state conditions in climate chambers and considered the occupants to be passive receptors detecting the surrounding environmental conditions. On the other hand, the adaptive comfort theory has been developed

from field studies in real buildings and considers the building occupants as active agents interacting with their built environment [22].

These models have already been integrated into several standards, such as ASHRAE 55 [23] and EN 15251 [24] (now EN 16798-1 [25]), which have also undergone several revisions [26]. E.g. ASHRAE 55:2020 includes major updates and more explicit and clear procedures.

The thermal comfort standards offer information for using their respective models in the design phase of new building projects or in the renovation of existing constructions, as well as when assessing the performance of existing buildings.

The interpretation and application of the comfort standards have important practical implications [1]. In particular, there is an urgent challenge to strengthen policy actions in the context of summertime conditions under increasingly extreme temperatures: energy use for space cooling is rapidly growing [27], and the summer comfort issues are increasingly difficult to tackle due to climate change and exacerbation of urban heat island [28–30].

The publication of the second ASHRAE Global Comfort database [31] has made available in a coherent way and in one single database the wealth of data collected in real buildings in the last decades and has been one of the basis for the recent update of ASHRAE 55, which incorporates some recent findings on comfort very relevant for the bioclimatic design.

In particular the role of air velocity in providing comfort in summer also at relatively high temperature and humidity levels is clearly shown in analytical and graphical format in ASHRAE 55 : 2020 and via easy to use online tools at <https://comfort.cbe.berkeley.edu/>.

Similarly, the publication of EN- ISO 52000 part -1 and part -2 has made available clearer definitions of energy levels and examples of ways of defining overall performance and nearly zero energy buildings. It is important to analyze how much of these advances are captured in policies, legislation and regulation as a prerequisite for their widespread adoption in design and construction practices.

3.2 Energy performance of buildings (EPBD) and a distinction between: nearly Zero Energy Building (nZEB) and Net Zero Energy Buildings (NZEB)

The definition of low or zero energy buildings has been discussed in literature and introduced in legislation in various forms. It is important to analyze which type of definition might

- better match objective, measurable, physical targets
- and serve the promotion of bio-climatic architecture.

A rational definition for buildings might also be a basis for a rational definition for districts.

In order to allow for a clear analysis, discussion and communication, we propose to keep a distinction between the definition of *nearly Zero Energy Building (nZEB)* given in EPBD and the *Net Zero Energy Building (NZEB)* terminology used in some other literature with many different definitions [32].

E.g. Italy has chosen not to use compensation for exported energy to the grid, apart from what presently unavoidable (because the calculation method is based on a monthly time step, so shorter steps are not available, unless a designer engages in hourly dynamica simulation). In

the wording of EN-ISO the situation might be described by saying that the parameter k_{exp} is set zero in principle, but slightly higher than zero in practice due to the monthly calculation method.

In order to describe the extent to which Member States might choose to consider the accounting of energy exported to the grid as a compensation of energy use, the standard EN-ISO 52000 introduces a k_{exp} factor, variable between 0 and 1. A value $k_{exp} = 0$ describes the absence of compensation, a value $k_{exp} = 1$ describes the situation where each unit of renewable energy exported compensates for one unit of energy used. Intermediary situations are possible.

The opposite situation, where all renewable energy exported to the grid over a year can be used to compensate (offset) energy taken from the grid over a year coincides with some of the definitions of **Net Zero Energy Building (NZEB)**, where “net” is intended as difference between energy use and energy generation or, equivalently between delivered energy and exported energy, all quantities being considered **over a period of a year**. In this case the parameter k_{exp} is set to 1.

Since details are what matters and makes the difference in effectiveness and impact of the various formulations, in order to illustrate in a clear way what are the issues, potentialities and risks connected to the choice of a specific definition, we analyse here a case of legislation from a European country, namely Italy, based on data and analysis from the H2020 project AZEB [33].

3.3 An example of national implementation of EPBD, with potentialities and limits

Italian implementation of EPBD an nZEB definition

In Italy, a nZEB is defined according to DM 26/06/2015 (minimum requirements) as a building which has a better performance than a “reference (virtual) building”, which is characterized by the same shape, location, orientation, function, window/wall ratio as the actual real one and has physical properties (e.g. U values) as fixed by law in the definition of the reference building (Figure 1). Consequently, there is no explicit fixed energy thresholds in kWh/(m²y) for being classified as an nZEB but it depends on a series of requirements (Table 2) which must be verified with respect to the reference building. This adoption of the reference building approach is actually a negative feature of Italian legislation, shared by only a few other Member States.

In addition, the annex 3 of the current Italian legislation about the promotion of renewable energy (Dlgs 28/11), coherent with the Directive 2009/28/CE, describes the minimum mandatory amount of energy provided via the exploitation of renewable sources for nZEBs. In particular: the systems producing thermal energy must be sized and realized to guarantee the contemporary fulfillment of two requests: a) to cover 50 % of the expected primary energy for domestic hot water (DHW) and b) to cover 50 % of the sum of the expected primary energy for DHW, heating and cooling, using energy produced from Renewable Energy Sources (RES).

Moreover, c) the power of the electrical renewable energy systems installed has to be greater or equal to $P = (1/K) \cdot S$, where S is the footprint surface of the building at ground level (in m²) and $K = 50 \text{ m}^2/\text{kW}$. A building with footprint of e.g. 100 m² should hence install a minimum of 2 kW photovoltaic. For public buildings, these obligations are increased by 10 %.

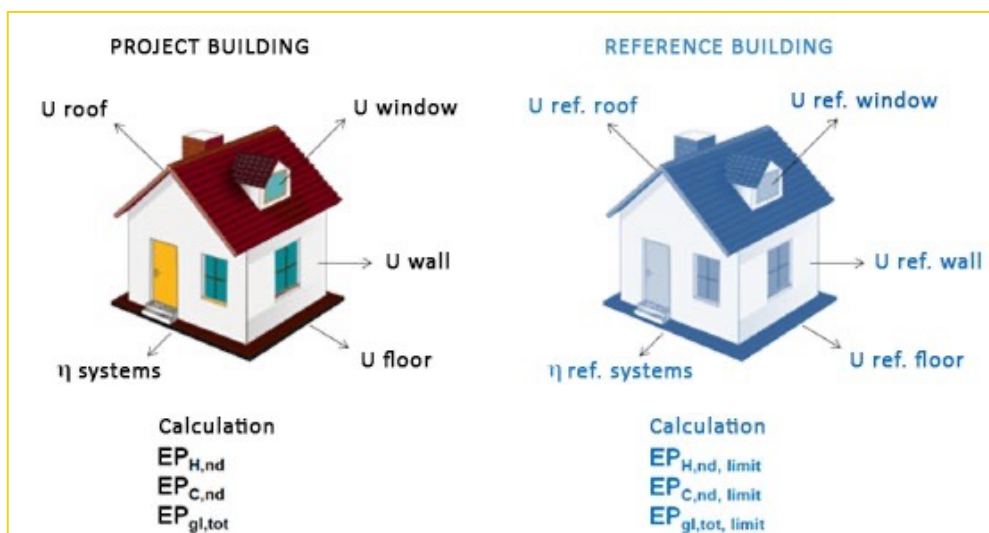


Figure 1: Project and reference building [34].

Table 2: Requirements for nZEB buildings according to Italian legislation (DM 26/06/2015 and DLgs 03/03/2011).

DM 26 June 2015 - annex 1			
Number	Indicator	Unit	Description
i	$H'_T < H'_{T,max}$	[W/m ² K]	Transmission heat transfer coefficient per unit of <u>thermal envelope area</u>
ii	$\frac{A_{sol,est}}{A_{sup,utile}} < (\frac{A_{sol,est}}{A_{sup,utile}})_{max}$	[-]	Equivalent summer solar area per unit of <u>useful floor area</u>
iii	$EP_{H,nd} < EP_{H,nd,limit}$ $EP_{C,nd} < EP_{C,nd,limit}$ $EP_{gl,tot} < EP_{gl,tot,limit}$	kWh/(m ² y)	<u>Energy need for heating</u> <u>Energy need for cooling</u> <u>Total global primary energy*</u> (includes non-renewable energy and renewable energy)
iv	$\eta_H > \eta_{H,limit}$ $\eta_W > \eta_{W,limit}$ $\eta_C > \eta_{C,limit}$	[-]	Average seasonal efficiency of the winter air conditioning system Average seasonal efficiency of the DHW system Average seasonal efficiency of the summer air conditioning system (includes moisture control)

*includes the following *services/end-uses*: winter air conditioning, DHW, ventilation, summer air conditioning, artificial lighting, transportation of people and things

Legislative Decree 3 March 2011 - annex 3	
Number	Description
i	cover 50% of <u>primary energy</u> for DHW through energy produced by RES (<i>on-site</i>)
ii	cover 50% of <u>primary energy</u> for DHW, summer and winter air conditioning through energy produced by RES (<i>on-site</i>)
iii	$P = (1 / K) * S$

(i) The **transmission heat transfer coefficient per unit of thermal envelope area** is a parameter to control the quality of the building envelope in terms of transmission losses. It is calculated as:

$$H'_T = H_{tr,adj} / \sum_k A_k \quad \left[\frac{W}{m^2 K} \right]$$

Where

- $H_{tr,adj}$ [W/K] is the transmission heat transfer coefficient of the envelope calculated based on ISO 14683:2007(E) and UNI/TS 11300-1;

- A_k = the area of the k-th component (opaque or transparent) of the envelope [m²].

(ii) The **equivalent summer solar area per unit of useful floor area** is calculated as:

$$\frac{A_{sol,est}}{A_{sup,utile}}$$

Where:

$$A_{sol,est} = \sum_k F_{sh,ob} * g_{gl+sh} * (1 - F_F) * A_{w,p} * F_{sol,est} \quad [m^2]$$

and:

- $F_{sh,ob}$ = is the shading reduction factor for external elements for the area of actual solar capture of the k-th glass surface, reported in July;
- g_{gl+sh} = is the total solar energy transmittance of the window calculated in July when the solar shading system is used;
- F_F = is the fraction of the area relative to the frame, the ratio between the projected area of the frame and the projected total area of the window component;
- $A_{w,p}$ = is the total projected area of the glazing component (window transparent area);
- $F_{sol,est}$ = is the correction factor for the incident irradiation, obtained as a ratio between the average irradiance in July, location and exposure considered, and the average annual irradiance of Rome on a horizontal scale.

(iii) **Total global² primary energy** $EP_{gl,tot}$ is calculated as:

$$\frac{EP_{gl,tot}}{A}$$

Where:

$$EP_{gl,tot} = EP_{PH,tot} + EP_{PW,tot} + EP_{PV,tot} + EP_{PC,tot} + EP_{PL,tot} + EP_{PT,tot}$$

- EP_{PH} is the total primary energy for winter air conditioning [kWh]
- EP_{PW} is the total primary energy for DHW [kWh]
- EP_{PV} is the total primary energy for ventilation [kWh]
- EP_{PC} is the total primary energy for summer air conditioning [kWh]
- EP_{PL} is the total primary energy for artificial lighting [kWh]
- EP_{PT} is the total primary energy for transportation of people and things [kWh]

A: is the useful floor area of the building [m²].

(iv) The **average efficiencies** η_u of the utilization subsystems (emission / supply, regulation, distribution and, if provided accumulation) and η_{gn} of generation are defined in Tables 7 and 8 of the Appendix A and include the effect of the consumption of auxiliary electricity.

² The pedix “gl” stands for “global” meaning that *primary energy* is referred to ALL end-uses considered in Italian legislation e.g. heating, cooling, hot water, ventilation, lighting in the case of non-domestic buildings, transport of people and things.

Importantly, the DM 26 June 2015 (annex 1) defines exactly how renewable energy produced *on-site* and used by the building can be counted in the calculation of the yearly *primary energy* use,

- Only to contribute to the same energy carrier (e.g. electricity with electricity)
- Only as long as the monthly energy use of that carrier is covered. **The excess production in one month (produced *on-site* and exported) cannot be used to compensate for overproduction in another month.**

Hence in fact what is called primary energy in the Italian legislation corresponds to the indicator *numerical indicator of non renewable energy use with compensation* of ISO 52000, with a k_{exp} factor much lower than 1.

Comments and potential improvements

The Italian National implementation of EPBD, which adopts in the definition of nZEB the indicators *energy needs*, *total primary energy*, fraction of *total primary energy* covered by renewables, and the *non renewable primary energy* as indicator for the Energy Performance Certificate, is in overall line with the EN ISO 52000 and consistent in the use of nomenclature. There is a shortcoming in the incomplete alignment between

- the indicators for the definition of nZEB
- and for the general Energy Performance Certificate

which may create confusion in the building market.

The use of the reference building procedure introduces a series of shortcomings:

- in the design phase it removes the signal to optimize building shape and orientation
- in the design phase it highly attenuates the signal to optimize the window/wall ratio
- in the real estate market it makes very difficult to compare the building under analysis to other buildings since there is no absolute threshold; the comparison on which the energy label is awarded is with the reference building model, which is specific to the building under analysis, rather than with all the other buildings.

The choice of calculating the *non renewable primary energy* use essentially with *no compensation* (the excess renewable production in one month - produced on site and exported to the grid - cannot be used to compensate for energy taken from the grid in another month, except from what is unavoidable due to the fact that a monthly calculation method is used) has the advantage of:

- focusing on the building and its success in fulfilling the definition of nZEB of EPBD art.2;
- avoiding incentives to use the energy grid as a virtual inter-seasonal energy storage which would transfer cost from the building to the grid, generate new environmental pressure (e.g. for construction of large storage facilities) and wrongly neglect the energy losses than any physical storage inevitably has.

3. Regulation for promotion of local bio & geo sourced materials with low embedded energy

We discuss in this chapter examples of regulation and standards for the promotion of local bio and geo sourced materials with low embedded energy.

4.1 Earth standards

After examining 40 different standards of 20 different countries, it was observed that adopted standard documents can be classified into three categories.

- Soil classification.
- Earth building materials.
- Earth construction systems.

In general, there are three types of documents governing the implemented building codes and standards.

- Standards and regulations issued by NSBs (national standards bodies).
- Normative documents issued by local/national organizations.
- Technical documents.

Table 3 shows countries with already established building standards and codes for earth and ecological buildings with their respective standard type.

Table 3: Countries with already established building standards and codes for earth and ecological buildings with their respective standard type.

Type of standard	Countries
NSB	Brazil, Colombia, Germany, France, India, Kenya, Kyrgyzstan, Nepal, New Zealand, Nigeria, Peru, Spain, Sri Lanka, Tunisia, Turkey, USA (New Mexico, California), Zimbabwe
Normative documents	Australia, Spain, Switzerland, Germany, France (under development).

In order to design and implement earth or ecological building codes into national or international standards, the following process of approval should be passed with the National Standards Bodies (NSB). First, the preparation of a draft development by a group of specialists (“the technical committee”) with proven competence in building with earth. Second, the prepared draft is presented to a broad range of specialists with a view to reaching a consensus between them. Third, presentation of the “consensus draft” to the NSB for final approval. In Europe, the draft must pass the EC Bureau for Standards for certification. Finally, the publishing of the finalized standard draft in a state decree.

Generally, the parameters covered in earth building standards are:

- Building materials/techniques: adobe, CEBs (compressed earth blocks), rammed earth, timber-framed structures with earth infill.

- Material properties: texture, plasticity/binding strength, natural constituents (organic, lime, salt content), shrinkage, compatibility, classification, test results, safety performance.
- Local conditions: earthquake damage.

Germany was one of the first countries to develop standards for earth and ecological building materials, known as DIN testing standards for different earth-based building materials.

- DIN 18942-1: 2018-12: Building materials in earth – part 1
- DIN 18945, DIN 18946, DIN 18947, DIN 18948 - Specifies the terms for applying clay building materials
- DIN 18942-100: 2018-12: Building materials in earth - Part 100 Conformity tests
- DIN 18945: Earth blocks—terms, requirements, test methods.
- DIN 18946: Earth masonry mortars—terms, requirements, test methods.
- DIN 18947: Earth plaster mortar—terms, requirements, test methods.
- DIN 18948: 2018-12: Clay plates – Requirements and test methods

The following tables display the different classes and strength properties of earth blocks, earth masonry mortars and earth plaster mortar building materials following DIN testing standards.

Table 4: Brick classes for earth blocks (EB) following DIN EN ISO 7500-1:2004-11.

EB Class	Compressive strength interval value (MPa)
EB2	2.0 - 2.5
EB3	3.0 - 3.8
EB4	4.0 - 5.0
EB5	5.0 - 6.3
EB6	6.0 - 7.5
Test procedure	DIN EN ISO 7500-1:2004-11

Table 5: Brick classes for earth masonry mortar (EMM) following DIN EN 1015-11: 2007-05.

EMM Class	Compressive strength interval value (MPa)
M2	≥ 2.0
M3	≥ 3.0
M4	≥ 4.0
Test procedure	DIN EN 1015-11: 2007-05

Table 6: Brick classes for earth plaster mortar (EPM) following DIN EN 1015-11: 2007-05.

EPM Class	Compressive strength interval value (MPa)	Tensile strength interval value (MPa)	Adhesive strength interval value (MPa)
S I	≥ 1.0	≥ 0.3	≥ 0.05
S II	≥ 1.5	≥ 0.7	≥ 0.10
Test procedure	DIN EN 1015-11: 2007-05		

Table 7 illustrates the area of applications of earth building materials depending on their mechanical strength according to DIN 18945-48 standards.

Table 7: Area of applications of earth building materials as a function of their strength following DIN 18945-48.

Brick Class	Area of application
Ia	Rendered, exposed external masonry in fare-faced timber-framed walls
Ib	Continuously rendered, exposed external masonry
II	Clad or otherwise constructed weather-protected external and internal masonry
III	Dry applications (e.g. deck infill, stacked walls)

4.2 Straw Bales standards

There are several regulations and standards in the context of straw bale construction. Some of them are given below [35]:

- BSF-112: Building Science for Strawbale Buildings (USA)
- ICC- International Code Council, 2018 International Residential Code for One- and Two-Family Dwellings- Appendix S: Strawbale Construction.
- 2011- Oregon Residential Specialty Code- Appendix R: Straw-Bale Structures (USA).
- IBC- International Building Code.
- BS 4046: 1991 Specification for Compressed Straw Building Slabs (British Standard).

4.3 Research activities and promotion

Some countries and universities are running research and detailed testing on the properties of the raw materials and of the manufactured building components. For example in Cameroon a cooperation among Faculty of Agronomy and Agricultural Sciences (FASA) of Dschang, Department of Earth Sciences, Faculty of Science, University of Ngaoundere, Department of Earth Sciences, Faculty of Science, University of Yaounde and the Local Materials Promotion Authority, produced detailed analysis on soil features and ceramics applications of clay in Lake Chad Basin [36].

Similarly, the Laboratory of Sustainable Energy Materials, Al Akhawayn University, Ifrane, Morocco is running a series of tests to investigate the effect of incorporating organic waste residue of agricultural activities (e.g. dry grass) on the physicochemical and thermomechanical performance of unfired clay bricks. The raw clay material used is of illite type, extracted from Bensmim in the Ifrane region. Bricks with dry grass filler reflected an acceptable compressive strength as well as a significant improvement in insulation properties, enabling energy saving and contributing to sustainable buildings with good mechanical functioning [37]. Other studies (e.g. utilization of recycled almond wastes as additives in unfired clay bricks) are under development.



Figure 2 Compressive strength experimental testing set up [37]

Support to those type of research activities might be an important policy option for National Governments both in Africa and Europe.

Also, some institutions have been created to promote the use of local materials once they are tested, e.g. the Local Materials Promotion Authority (MIPROMALO), Yaoundé, Cameroon.

It is also of high importance the recognition of local, low embedded energy materials by financial institutions. E.g. the World Bank states in a report [38] the potential large importance of “materials that may be “temporary” or “traditional” or “semi-permanent”, but can play a relevant role in the provision of affordable buildings and the creation of local jobs”.

“While these materials are not preferred by many governments, experience shows that they can be durable in addition to being inexpensive and locally sourced. ” ... “Recognizing the importance of these materials to the affordable housing sector, Cameroon established a Local Materials Promotion Authority (MIPROMALO) to promote the use of locally manufactured materials that reduce the cost of housing“ [38]

4. Clean cooking as a complement to bioclimatic architecture for lowering energy use and improving IAQ

The world energy outlook 2022 report of IEA[39] emphasises that the global energy crises in the reported year could push over 100 million people back to using biomass for cooking. Today, over half of the African population relies on wood gathering and agricultural and animal waste for cooking applications. The traditional use of this energy account for final energy use increased by over 40% between 2010 and 2019, as reported in the African Energy Outlook 2022 [40]. The same publication reports that “A lack of clean cooking contributes to 3.7 million premature deaths annually, with women and children most at risk. Poor indoor air quality is a leading cause of premature death worldwide. In Africa alone, women and children account for 60% of early deaths related to smoke inhalation and indoor air pollution.”

To cope with the challenges, **the development of efficient and clean cooking technologies should be integrated with the promotion of bioclimatic architecture and passive techniques** in buildings. This would have a critical role to play in reducing energy use, improving indoor air quality (which is cause of major health problems when open flames are used indoors) and in energy democratisation in the developing world.

We provide here a short summary of some initiatives aimed at propting “clean cooking” which might be taken into account while developing policies to support bioclimatic architecture, with a larger, holistic perspective, while maintaining the traditional food culture and habits.

Moroccan test for preparation of tagine in electric pressure cookers

A collaboration among the International Energy Agency (IEA) and the Kingdom of Morocco, with support from EU has performed tests about (more) efficient electric cooking “In collaboration with the Modern Energy Cooking Services Programme (MECS), five cooking trials were undertaken to assess the suitability of **electric pressure cookers** (EPCs) for cooking typical Moroccan dishes, and preliminary assessments were carried out for the impacts on cooking costs, household bills, electricity grids, CO2 emissions and subsidy bills.



clay tagine pot, stovetop pressure cooker



electric pressure cooker

Figure 3. Various cooking techniques

These impacts were assessed considering three household types:

- i) urban grid-connected households relying 100% on butane for their cooking needs
- ii) rural grid-connected households that use a combination of butane and firewood and
- iii) rural off-grid households that rely on firewood for cooking (as well as space and water heating).

The findings of the preliminary trials have demonstrated that:”

“Some of the most commonly cooked dishes such as meat and/or vegetable stews (such as tagines) and soups are very well suited for cooking in an Electric Pressure Cookers, providing significant time, energy and cost savings.”

Potential improvementst to injera baking in Ethiopia

In a large part of Ethiopia, 82% of the population including 54% of the urban population, rely on solid biomass cooking fuel³. The traditional cooking setup is based on the use of biomass via processes with very low energy conversion efficiency. In Ethiopia, *injera* (flat bread from a cereal called teff) baking accounts for a large share of household energy use in urban area. Studies estimated the efficiency with which energy is used in the traditional setup of injera baking to be around 5–15%. In addition, biomass usage for injera baking is associated with rapid deforestation and indoor air pollution.

As reported in wikipedia: „In Ethiopia and Eritrea, a variety of stews, salads, ... and more injera (called injera firfir) are placed on the injera for serving. Using one's hand (traditionally only the right one), small pieces of injera are torn and used to grasp the stews and salads for eating. The injera under these stews soaks up the juices and flavors of the foods, and after the stews and salads are gone, this bread is also consumed. Injera is thus simultaneously a food, eating utensil, and plate. When the entire "tablecloth" of injera is gone, the meal is over. In Ethiopia and Eritrea, injera is eaten daily in virtually every household. “

Some technical proposals have been presented for

- feeding the baking plate with solar energy, succeeding to deliver the requied cooking temperature [41]
- improving the layout of the electric resistances embedded into the clay baking plate, in order to find a good comprise between energy efficiency, uniformity of temperature distribution on the plate, start-up time. [42]

³ R.Sieff, K. Troncoso, M. Tesfamichael, 'Ethiopia eCooking Market Assessment'. MECS and EndeV, Feb. 2022 [Online]. Available: <https://mecs.org.uk/wp-content/uploads/2022/02/MECS-EnDev-Ethiopia-eCooking-Market-Assessment-presentation.pdf>



Figure 4. Injera being cooked on a griddle. The bottom surface of the injera, which touches the heating surface, has a relatively smooth texture, while the top is porous. This porous texture makes injera good for scooping up sauces and dishes. Source: <https://en.wikipedia.org/wiki/Injera>



Figure 5. An electric stove for baking injera. Source: <https://en.wikipedia.org/wiki/Injera>

5. Financing: credit and micro-credit

Apart from the availability of incentives, households and businesses are investing in the construction of a building their own savings or financial resources, plus resources obtained through credit by financial institutions in the form of standard credit or micro-credit.

Wikipedia (<https://en.wikipedia.org/wiki/Microfinance>) reports that “Central banks and mainstream banks are now more intimately engaging in the financial inclusion agenda than ever before, though it is a long road, with 35–40% of world's adults remaining outside formal banking system, and many more remaining "under-banked".” And “Microfinance is a category of financial services targeting individuals and small businesses who lack access to conventional banking and related services. Microfinance includes microcredit, the provision of *small loans* to poor clients; savings and checking accounts; microinsurance; and payment systems, among other services. Microfinance services are designed to reach excluded customers, usually poorer population segments, possibly socially marginalized, or geographically more isolated, and to help them become self-sufficient”.

“The Africa Microfinance Network (AFMIN) is an association of microfinance networks in Africa resulting from an initiative led by African microfinance practitioners to create and/or strengthen country-level microfinance networks for the purpose of establishing shared performance standards, institutional capacity and policy change. AFMIN was formally launched in November 2000.”

Some cases of abuse have been signaled and public policy should ensure that fair and sound rules of conduct are followed or enforced. E.g. in Nigeria, cases of fraud have been reported. Dubious banks promised their clients outrageous interest rates. These banks were closed shortly after clients had deposited money and their deposits were lost. The officials of Nigeria Deposit Insurance Corporation (NDIC) have warned customers about so-called "wonder banks".

The issue of financing is important because apart from carbon finance (green climate fund, adaptation fund or other funds set up under environmental conventions and other developed countries) few financial institutions have set up credit lines dedicated to energy efficiency and materials. Scaling up public international Energy Efficiency financing to accelerate the market transformation of the building sector in developing countries is important. While the banks ultimately decide the financing allocations, beneficiaries play a major role in shaping those decisions. National development plans and Nationally Determined Contributions are possible navigators to ensure that policy and financing decisions are aligned with Climate protection goals and the other sustainability objectives (soil and water protection, reduction of use of materials,...)

To up-scale Energy Efficiency investments it is also important for national governments and financial institutions might have easy access to transparent data and standards which prove the effects of the programmes, as eg. the ***International Performance Measurement and Verification Protocol (IPMVP)***.

Financing: State incentives or direct investments, and the collection of resources

To steer the process towards high energy and comfort performances and affordability, there is generally a need for Public Policies based on economic incentives and support to design, construction and components for low or zero energy buildings,

The choice of the ways for financing has very relevant implications. Incentives schemes might be financed via three main typologies for raising the needed funding:

1. Through general taxation
2. Through a levy on energy prices, e.g. according to art 7 of the Energy Efficiency Directive in Europe
3. Through Public debt (payment by the State, probably to be paid back via taxation in the future)

As for the possibility to fund energy efficiency programs via general taxation, this is considered coherent with healthy national economic activity. Encyclopedia Britannica reports in a brief synthesis: “Keynesian economists claim that the government can directly influence the demand for goods and services by altering tax policies and public expenditures. ... Following the global financial crisis of 2007–08 and the ensuing Great Recession, interest in ongoing theoretical refinements of Keynesian economics (so-called “new Keynesianism”) increased, in part because Keynesian-inspired responses to the crisis, where they were adopted, proved reasonably successful.”

Taxation schemes might be used at the same time to promote energy efficiency and bioclimatic architecture, to improve equality and ameliorate economic activity. For example an International Monetary Fund analysis from a detailed database of a large number of countries concludes that inequitable distribution of wealth is detrimental to the economy, even from the limited perspective of the GDP parameter [43]. The analysis concludes that “narrowing of inequality helped support faster and more durable growth, apart from ethical, political, or broader social considerations”. The same analysis goes on to note that ‘developed’ countries have ample room to develop ‘rebalancing fiscal policies’.

Obviously the use of earmarked or general taxation will allow to finance the programs without or with low reliance on public debt.

Another financing route which may limit the reliance on public debt and avoid the risk of this debt falling on medium and low-income population in the future, would have to rely on typologies of financing mechanisms that do not draw on the State budget. In Europe these mechanisms already exist and should possibly be strengthened and better targeted. Those EU mechanisms might be used as “case studies” for Africa, as hinted e.g. in some documents of ECREE – ECOWAS, so we discuss some of their pro and cons in this chapter.

They derive from Articles 7 and 7-bis of the European Energy Efficiency Directive (2018, recast of the 2012 Directive) and apply the obligation to promote energy savings that this Directive assigns to energy companies (electricity and gas). This obligation has been included in the European Directive also thanks to the fact that, since 2004, this obligation has been in operation in Italy through the mechanism of the *Titoli di Efficienza Energetica* (TEE, also called White Certificates), designed by the Ministries of the Environment and Industry with the technical advice of the end-use Efficiency Research Group (www.eerg.it). In essence, the Italian legislator assigns energy distribution companies - i.e. those that own and maintain medium voltage electricity or gas distribution networks - an annual energy saving target to be achieved by promoting saving actions among their customers, actions that are certified through the issuing of *Titoli di Efficienza Energetica* - TEE.

Distributors are reimbursed for their costs for the promotion of energy efficiency (incurred directly or through Energy Service Companies, ESCOs) through a fund created with a small component of the energy price paid by end users. In more recent years, another mechanism (the *Conto Termico*) was introduced in Italy; also this mechanism promotes energy savings (particularly in terms of thermal energy) and is similarly financed by a small component of the energy price. The resulting fund is managed by the state and allocates funds through tenders, in which the public administration can also participate.

Both type of mechanisms can therefore finance in particular deep renovations of buildings, drawing funds from specific components of energy tariffs.

This way of financing underpins a number of **positive features** common to white certificates and the *Conto Termico*:

- as they are not financed by tax levies, they are totally external to the state budget and therefore do not have a negative impact on the debt/GDP and deficit/GDP parameters.
- on the contrary, by promoting economic activity, they can produce an increase in the State's tax revenues without disbursement from the budget, and therefore an improvement in those ratios.
- since they do not affect the state budget, they do not have to be voted each year in the financial law and are therefore an intrinsically stable mechanism. In Italy, they have been working in 5-year cycles between reviews are in operation since 2004, and have constituted the bulk of Italian energy-saving efforts agreed with Europe.
- they can therefore be used intensively to reduce the energy needs for heating and cooling of buildings, with measurable and certified results: certification of savings is in fact a basic feature of all these types of programs worldwide. Examples of evaluation methodologies may be found at ***International Performance Measurement and Verification Protocol (IPMVP)***⁴.

Energy Efficiency Certificates are used in a number of countries in EU. E.g. the April 2020 report by the French Ministry of the Environment on the use of Energy Savings Certificates shows that they are largely used in France to combat energy poverty by tackling in priority buildings with a high "energy need for heating or cooling" [44].

It should be noted that, if used effectively (with the support of correctly implemented evaluation methodologies), the investments in end-use reduction charged in the tariff would slightly increase the price of the unit of energy, but would reduce energy use and thus the bill for households, businesses and the nation, as well as permanently reducing emissions and pollution [45].

In order to ensure that the bills of the poorer sections of the population are not burdened by the scheme, there are two alternatives: making the levy on the price of a single unit of energy (kWh or m³ of gas) increase with consumption, according to the "polluter pays" principle (so called "progressive tariffs") [46], or guaranteeing economic aid to households in difficulty, in

⁴ https://en.wikipedia.org/wiki/International_performance_measurement_and_verification_protocol

general, not linked to energy expenditure, but which would help them to bear the cost of the bill until, for example, their house is insulated and the bill falls. Similar mechanisms already exist, and can be calibrated to the situation. Progressive tariffs have the strong advantage of creating a price signal towards energy savings; by making the last units of energy (and hence the first to be eliminated by energy efficiency or sufficiency measures) more expensive, it reduces the payback time of the investment needed.

A possible formulation of progressive tariffs is presented in Figure 6. The marginal price (price of the last unit bought) for the consumer grows with the number of units used over a certain billing period. The price paid can be distributed among a) the supplier (distribution or supply company), b) a fund to finance energy efficiency programs (CCSE) and c) the State as e.g a Value Added Tax. The payment to the supplying company per unit of energy is flat (or degressing with consumption) in order to reduce the incentive to promote sales with a view to increase profits, and can be regulated by a Regulator to allow a fair profit.

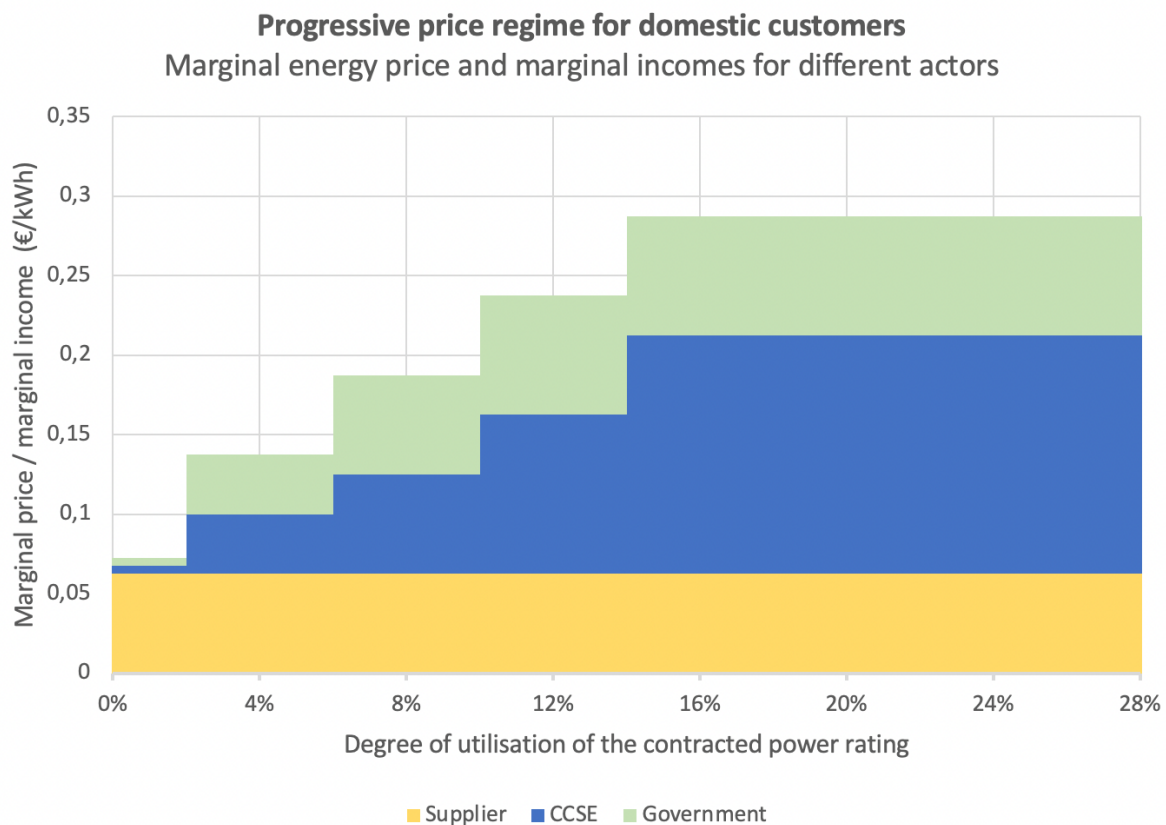


Figure 6: top line: marginal price for the consumer (price of the last unit bought) grows with the number of units used over a certain billing period. The price paid can be distributed among the supplier (distribution or supply company), a fund to finance energy efficiency programmes (CCSE) and the State as e.g a Value Added Tax

The funds collected through the energy price levy can be managed by an independent administrator, which can be selected through a special call for tenders (e.g. an energy efficiency expert firm, a university research group, an agency formed by municipalities and experts could participate). Examples are, at national level, entities such as The Energy Saving Trust in the UK, and, at local level, entities such as EnergiePositif, active in the Paris region. On the other hand, funds can be managed by energy distributors or sellers who are subject to

the saving obligation of Art. 7 of the Energy Efficiency Directive (e.g. energy companies owned by municipalities in Germany, energy distributors in Italy, energy sellers in France).

The fact that the above type of policies (promotion of energy efficiency financed via a levy on energy prices, progressive tariffs with a guaranteed minimum level of energy per household at low price, while prices grow with consumption at higher levels of consumption) may be applied and be effective in the Global South was proposed already in 1987 in the pioneering book [47].

Those energy experts (respectively from Brazil, Sweden, India and USA) were discussing those type of policies in the chapter 5 of the book, where they presented the need both for the global North and the global South, to:

- **eliminate energy supply subsidies**
- adjust utility rates to reflect **marginal rather than average costs**, but allowing rates to vary with the consumption level (**progressive tariffs**) with a minimum guaranteed consumption level at reasonably low price.

As for criteria for the selection of where to allocate the incentives, it is important to include in the calculation external costs, costs connected to risks of extreme events, and costs connected to lock-in in situations of high consumption.

For example if new buildings are not constructed to state of the art standards, the resulting building stock would be locked in a high consumption state and continue to unnecessarily take up a high amount of energy for decades thus generating high costs in the medium and long term.

On apparently counterintuitive prioritization of investments, see a recent paper by researchers of World Bank “Climate policy: When starting with the most expensive option makes sense” [48]. From which we quote: “Traditional climate economics models recommend capturing the cheapest opportunities to reduce emissions first – the ‘low hanging fruits’ – and keeping the most difficult options for later. This approach sounds like common sense, and it is at the basis of the ‘marginal abatement cost curves’ (MACCs) approach (McKinsey and Company 2009). .. but “in many cases, delaying action is particularly expensive (and action particularly urgent) in sectors where decarbonization is difficult or expensive. Hence our title.”

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