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22-24 settembre 2021

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LCA in building sector policies

Monica Lavagna[1*], Andrea Campioli[1]

Abstract: The potential of the LCA methodology in policies, and particularly in building sector policies, is a topic of growing interest, even if it is still rarely applied.
The LCA method can be used to support the definition and verification of policies or it can be requested within the policies as a tools to support the project choices.
The paper analyzes the few applications of the LCA method in the policies of the building sector, both in the European and in the Italian context, highlighting in particular the second approach, namely the request to apply the LCA method during the design process. The objective of the paper is to show good practices in order to support policy makers in LCA application and to highlight potentialities and limits in the current applications.

1. LCA into policies

The adoption of Life Cycle (LC) criteria, methods and metrics for assessing the sustainability of buildings, i.e. by adopting the Life Cycle Thinking (LCT) approach and the related assessment methodologies Life Cycle Assessment (LCA), Life Cycle Cost (LCC) and Social LCA (SLCA), is internationally recognized as necessary to define effective ecological transition actions, estimate effects and monitor results (EC, COM (2019) 640, European Green Deal).

Over the last twenty years, LC methodologies, and in particular the use of LCA, has become mature, moving from its academic origins and limited uses, primarily in-house in large companies (Sonnemann et al., 2017), to a broader use into corporate environment (in support of decision-making process and communication to consumers, clients and/or government institutions). This assimilation has not occurred in the institutional field. Whilst LC methodologies are internationally recognized and recalled by European Commission their successful integration into the process of defining policies by public authorities appears very limited (Allen et al., 1995). Barriers that limit the application of LCA within the public policy development process range from lack of technical knowledge and LCA understanding on the part of policy makers, to a lack of trust in LCA process and results (Seidel, 2016).

The EC Communication on *Better Regulations for better results* (EC, COM (2015) 215) includes life cycle analysis on models and methods for evaluating the effects of policies, in order to support the impact assessments and environmental benefits associated to different policy options. A first overview on the potential roles of LCA in public policies, with particular reference to environmental impact assessment, is outlined in the JRC report (EC JRC, 2016). It proves that LCT and LCA, and correlated tools (Life Cycle Cost – LCC, Social Life Cycle Assessment – SLCA),

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have an important role throughout the process (from the definition and design of policies to the implementation, monitoring and evaluation of their results) to identify and correct possible negative spillover effects.

Starting from the 1990s, LC methods have been repeatedly mentioned in various European environmental policies (e.g. Integrated Product Policy, Thematic Strategy on the sustainable use of natural resources, Green Public Procurement) and today they are at the core of the European Green Deal strategies, with the related set of actions: A New Circular Economy Action Plan, Climate Neutrality, A zero pollution Europe, Clean Air and Water Action Plan, Clean Reliable and Affordable Energy, Sustainable Production and Consumption, Biodiversity Strategy, Mobilizing Research and Fostering Innovation.

In this context, the construction sector has been identified as a priority for the application of sustainability strategies, due to its high impacts. In proof of construction as a crucial sector to tackle the green transition (EC, COM (2012) 433, *Strategy for the sustainable competitiveness of the construction sector and its enterprises*), the European Commission has set it as one of the priority targets of the strategy for a sustainable built environment (EC, COM (2020) 98, *A new Circular Economy Action Plan*), focused on the increase of materials efficiency and the reduction of climatic impacts. For implementing this paradigm shift, it is essential to have metrics and assessment procedures for comparing alternative options and make the most effective choices towards circularity and sustainability, looking on their extended systemic dimension.

On the one hand, the LCA method can be used to support the assessment of the sustainability of policies (i.e. to assess the environmental effects of a given policy). On the other hand, the LCA method can be integrated into policies (i.e. requiring LCA as a tool for verifying the design choice, during the development of the project). This second option is certainly the most interesting, because it allows to spread the use of the LCA method throughout all the operators of the building process.

The published scientific papers related to building's LCAs do not offer solid background information for policy-making without deep understanding of the premises of a certain study and good methodological knowledge (Säynäjoki et al., 2017). A greater diffusion of the use of the LCA is needed, also to be able to contextualize the choices.

In recent years the issue of decarbonization has received privileged attention. The EU policies related to energy efficiency and zero energy buildings focused their attention only on two environmental indicators (energy and CO_2 emissions) and only one phase of the life cycle (operational), creating burden shifting (Paleari et al., 2016). To obtain effective results for climate neutrality, it is necessary to analyze the entire life cycle and not just a phase. To obtain effective results for environmental sustainability, it is necessary to analyze several indicators, not just energy consuption or carbon footprint.

Many PAs have enforced environmental action plans at multiple levels (european, national, regional, municipal). However, the verification of the environmental effectiveness of these measures is not performed through a systemic LC approach, but considering in isolation the environmental matrices (energy, water, waste, air) and the single phases of the building process (e.g. energy efficiency and decarbonisation of buildings use phase, C&D waste management). Optimizing individual environmental issues or individual stages of the life cycle could lead to a shift in impacts from one environmental issue to another and from one stage of the life cycle to another.

The ecological transition demands a holistic approach and an overview of the entire life cycle. LC methodologies allow replacing the environmental criteria based on prescriptive/object-based

approach widely adopted in current practice (e.g. use of recycled materials), with criteria based on performance approach (es. reduction of eutrophication), proving the environmental effectiveness of the action with regard to the desired objectives of the policy.

For enhancing the effectiveness of PA policies in the field of environmental sustainability of buildings, the implementation of environmental criteria, assessment-verification-monitoring procedures, reference targets/benchmarks based on LC methods are necessary (Lavagna et al., 2018).

It should be noted that the introduction of criteria that promote the use of LCA in policies is generally accompanied by the development (by public administrations, generally at national level) of support tools, such as databases and software (which also make the evaluations methodologically uniform and comparable).

Governments can play a pivotal role by providing financial incentives or requiring the LCA application during the design process. LCA can be used for a wide variety of policy objectives: allow subsidies for retrofitting or new construction; select between demolition or retrofitting; authorise construction permits following the calculated environmental impacts.

2. LCA application in building sector policies in Europe

Through regulations, incentives and initiatives, governments and PAs clearly have an important role to play. The analysis of some application experiences can be useful to understand how the LCA method can be integrated into the building sector policies.

2.1. The EU framework for sustainable buildings: Level(s)

Level(s), the EU Commission's framework for sustainable buildings, is a framework of common European indicators to measure the sustainable performance of buildings across their whole life cycle. It looks at the full lifecycle of buildings to address their huge potential for emissions reductions, efficient and circular resource flows, and supporting the health and wellbeing. It will be a powerful source of data and insights for national policy-makers looking to build sustainability and circularity into their building codes. It focuses on six 'hotspots' for environmental impact through the whole building life cycle: greenhouse gas emissions (Life cycle Global Warming Potential, kg CO_2 eq./m^2/yr), resource efficiency (design for adaptability and deconstruction), water use, health and comfort, resilience and adaptation to climate change, and optimised life cycle cost and value. Aligning national construction policies with Level(s) - particularly public procurement in the short term, will be key to driving wide uptake.

2.2. The DGNB Certification System in Germany

In 2009 the German Sustainability Building Council (DGNB) together with the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) developed a voluntary certification system for sustainable buildings, the DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen). The DGNB Certification System is being recommended by the BMVBS for good planning and building practice. The BMVBS has drawn up guidelines for a procedure for the public recognition of certification systems.

LCA and LCC are a mandatory requirement in the certification process of DGNB. Even if it is a voluntary certification, DGNB certifies more than 200 buildings annually, thanks to the support and recognition of the Ministry.

2.3. France

The Carbon Energy *E+C- label* is a national experiment launched by the government in 2016 to test the requirements of the future RE2020 *Environmental Regulation for new buildings* on pilot projects, that commits positive energy buildings with a low carbon footprint over the entire life cycle. On the energy part (E+), the performance scale of a positive energy building has four levels from Energy 1 (E1) to Energy 4 (E4). On the environmental part (C-), the carbon performance is assessed on the basis of greenhouse gas (GHG) emissions over the entire life cycle and emissions relating to the building products and equipment.

The *Bâtiments à Énergie Positive et Réduction Carbone* of the Agence de la transition écologique, requires a full LCA of the building, based on EN15978, considering at least 9 indicators.

This requirement is supported by the previous work done: for over a decade, France government has been supporting the development of product certifications, ie. Fiche de Déclaration Environnementale et Sanitaire (FDES) for construction products and Product Environmental Profiles (PEP) for equipment. Since 2004 FDES documents have been regulated by the AFNOR NF P 01-010 standard and, since 2014, by the NF EN 15804+A1 standard and its national supplement NF EN 15804/CN. All national certifications are contained in a database, Inies, and they can be imported into the Elodie software (developed by CSTB) for the LCA of buildings.

2.4. The Netherland

In the Netherlands, the use of the LCA tool is envisaged by a legislative decree issued in 2012 (*Milieuprestatieberekening van gebouwen*, art.5.8 and 5.9), which indicates the mandatory declaration of the environmental performance of buildings (MPG) for new homes and buildings for offices with an area greater than 100 m^2. The LCA is accompanied by a translation of the values of the eleven impact indicators into a single value through the monetization method (Giorgi et al., 2020). The LCA is supported by environmental data from the "National Environmental Database" (NMD). This database consists of a national EPD database integrated with an Ecoinvent database, harmonized to the Dutch context, for products without EPD.

2.5. Belgium

In order to measure the environmental performance of buildings in Belgium the development of an impact calculation LCA methodology (MMG) has been promoted since 2014. It allows to convert environmental impact values into monetary value (Giorgi et al., 2020). Since 2018, a simplified tool, based on the LCA methodology called TOTEM or "Tool to Optimize the Total Environmental impact of Materials", (OVAM, 2018) has been developed particularly for designers, investors and policy makers.

2.6. Austria

The Ecological and biological buildings department of the Austrian Energy Agency developed some Ecological building tools (Ecosoft LCA software and Baubook LCA database), finalized to spread the use of LCA, supported also by political incentives. From this pathway, the *Ecological Building Ecopass* has been processed. It is a certification scheme based on 50 indicators related to energy efficiency and material selection. In particular, the ecological assessment of thermal envelope materials has to be measured by the Eco-index, based on three indicators: Non-renewable primary energy consumption PEIne, Greenhouse impact potential GWP, Acidification potential AP. On the basis of the score achieved (eco-level), different levels of incentives or loans are applied.

Recently, the Austrian Energy Agency promoted a project, funded by the Federal Ministry for Transport, Innovation and Technology in the programme Building of Tomorrow, with the objective of developing a combined economic-ecological life cycle assessment model. As result, the software LEKOECOS was developed. It is based on the structure of the life cycle cost model LEKOS of the Donau-Universität Krems, Department für Bauen und Umwelt, and the ecological valuation tool Ecosoft of the Austrian Institute for Building and Environment (IBO).

2.7. Svizzera

The Swiss energy certification *Minergie* requires both the calculation of the operational energy, and the calculation of the embodied energy, according to the national standard SIA 2032. The maximum limit of 50 kWh/m^{2}a is fixed, considering the entire building and a service life of 60 years. The recommendation document "Eco-balances for construction" by the coordination conference of public building owners (KBOB) is the reference to support the assessment.

3. LCA application in building sector policies in Italy

Also in Italy there are some examples of application of the LCA in the building sector policies, which constitute interesting beginnings of a path yet to be built, in the direction of a greater homogeneity of approach and diffusion.

3.1. Environmental Minumium Criteria for Green Public Procurement

The Italian Ministry of the Environment has developed, in the framework of the National Action Plan on Green Public Procurement (PAN GPP), the Minimum Environmental Criteria (CAM) for the construction sector, ie for the tender related to design services and related to construction works. In the first version of 2017, there was no specific reference to the LCA, but only to the LCC. However, the EPD certification was introduced as a tool for verifying certain requirements, thus giving impetus to this tool, based on the LCA. In the new version, currently still in the public consultation phase, awarding scores are given to the design team and/or to the construction company that use an LCA and an LCC to improve the environmental and energy sustainability of the solution proposed.

3.2. The Lombardy Region Interreg project "LCA4Regions"

The Lombardy Region is currently a partner of an Interreg Europe project on the use of LCA in policies. The LCA4Regions project is expected to contribute to the more effective implementation of environmental policy instruments by the application of Life Cycle Methodologies. The project will contribute to improve policy instruments introducing the LCA in all steps of policy cycle management and to enlarge the circle of end-users that will benefit from making conscious decisions on resource efficiency and investments using the LCA. In particular, the Lombardy Region is focusing the attention on policies of the building sector.

3.3. Reinventing Cities call for urban regeneration in Milan

Reinventing Cities is a global competition organized by the C40 Cities Climate Leadership Group to drive carbon neutral and resilient urban regeneration. The first edition in 2018 involved 19 cities and 49 underutilized spaces; the second edition in 2020 involved 9 cities and 25 sites (4 in Milan). The key challenges to deliver carbon-free projects are Energy efficiency and low-carbon energy and Life cycle assessment and sustainable materials management. For the challenge related to the LCA of the intervention, the Carbon footprint of the building across the whole life cycle of the project (considering production, construction, operation, maintenance, end-of-life phases) in tCO_2e or tCO_2e/m^2 is required. The LCA results of the project must be compared with the LCA results of a "Business As Usual" (BAU) building, i.e. a standard building with the same shape, function and location, built with conventional technical solutions and performances (in compliance with regulatory limits). The final goal is to demonstrate the reduction of impacts in terms of GWP.

3.4. "Territorial governance plan" of the Municipality of Milano

In the new "Territorial governance plan" of the Municipality of Milan, issued in 2020, the Article 10 is related to "environmental sustainability and urban resilience". This article specifically requests that "interventions must act in terms of reducing and minimizing carbon emissions". In particular, it is required that "for restoration, conservative rehabilitation and building renovation interventions, a 15% reduction in CO_2e emissions is mandatory with respect to the emission values associated with the global energy performance limits, if the legislation requires verification; for the interventions of new construction, urban restructuring and building renovation with demolition and reconstruction, the achievement of carbon neutrality is mandatory". "The above performances can be achieved through the use, in alternative or composite form, of the following design elements: i. solutions with high energy performance; ii. re-naturalization interventions, also through forms of green integrated in the buildings; iii. technologies for reduced water consumption and for the reuse of rainwater; iv. use of sustainable and/or recycled content materials; v. adoption of surface finishes with a high solar reflectance coefficient; vi. solutions for sustainable mobility". The reference to sustainable materials seems to imply a life cycle approach, even if no specific reference is made to the carbon footprint or to LCA.

4. Conclusions

The LCA method is beginning to be inserted within the building sector policies, still in a fragmented and episodic way, but with growing interest on the part of the PAs. However, the lack of expert decision makers on methodology and the lack of homogeneous guidelines at European level risk leading to some distortions.

In particular, the choice, made by some PAs and also by the European Commission in the Level(s) framework, to use only the Life cycle Global Warming Potential indicator, can lead to burden shifting on other types of environmental impacts and can orientate the construction sector towards specific choices, such as the use of wood, not verified in their overall impact. The LCA method should be applied in its two connotating characteristics, namely the life cycle vision and the extension to a wide range of environmental indicators.

Furthermore, there are some reservations about PAs overall capacity to do LCAs in-house (to support policies development) and verify LCA results (when there is a requirement in the call or in the local regulation) competently without external support. Therefore, the development of skills in government offices (training for PAs) could be a strategy to promote the spread of LCA into policies.

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