Pan African University
Institute of Water
and Energy Sciences

PAN-AFRICAN UNIVERSITY

INSTITUTE FOR WATER AND ENERGY SCIENCES

(including CLIMATE CHANGE)

Master Dissertation

Submitted in partial fulfillment of the requirements for the Master degree in

Energy policy

Presented by

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Investigating the planning process and the environmental regulatory framework in order to promote renewable energy in Algerian cities.

Defended on 02/09/2019 Before the Following Committee:

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Declaration

I **Imane BOUKHATEM** hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

Abstract:

Under the domination of powerful national actors , cities cross Algeria still struggle to position themselves in the design of policy alternatives to achieve energy transition. The aim of this study was: to ascertain the gaps that blocks the transmission of national planning policies to city scale, to examine the regulatory framework that refers to environment interfering with the built environment and to present samples of qualitative and quantitative tools that can be used by city experts to promote the solar energy in cities without scarifying the architectural quality of the built environment. The adopted research design is qualitative. A global approach analysis of the different urban planning and environment protection instrument was presented. To cover all the aspects of the regulatory framework, a content analysis of the texts related to the building sector on one hand and those treating renewable energy and energy efficiency preoccupations on the other hand was done. From the analysis it was highlighted that there is a conflict of scale between the national and the local scale. The national instruction seems too ambiguous to be translated on city scale. In addition, the texts relating to energy are restricted to a set of methods of calculation and standards that can be applied only at a late stage of the design. Finally, the thesis proposes a specific local instrument dealing with architectural details. Treating the synergy of energy efficiency and renewable energy preoccupations and architectural quality constraints. It intervenes the planning processes and support decision making regarding the use of solar technologies.

Key words:

Renewable energy, solar active and passive technologies, planning instrument, environmental regulations.

Résumé:

Sous le domination des acteurs nationaux puissant, les villes algerienne se batten toujours pour se positionner dans la conception d'alternatives politiques de transition énergitique. L'objectif de cette étude était de définir les lacunes qui bloquent la transmission des politiques nationales de planification à l'échelle de la ville. Examiner le cadre réglementaire qui fait référence à l'environnement interférant avec le cadre bâti. Et présenter des échantillons d'outils qualitatifs et quantitatifs qui peuvent être utilisés par les experts municipaux pour promouvoir l'énergie solaire dans les villes sans sacrifier la qualité architecturale. La methode de recherche adopté est qualitatif. Une analyse globale des différents instruments de planification urbaine et de protection de l'environnement a été présentée. Pour couvrir tous les aspects du cadre réglementaire, une analyse du contenu des textes relatifs au secteur de la construction, d'une part, et à ceux traitant des préoccupations relatives aux énergies renouvelables et à l'efficacité énergétique, d'autre part, a été réalisée. L'analyse a mis en évidence l'existence d'un conflit d'échelle entre le niveau nationale et le niveau locale. Les renseignement national semble trop ambigu pour être traduit à l'échelle de la ville. En outre, les textes relatifs à l'énergie sont limités à un ensemble de méthodes de calcul et de normes qui ne peuvent être appliquées qu'à un stade tardif de la conception. Enfin, la thèse propose un instrument local spécifique traitant des détails architecturaux. Traiter la synergie des préoccupations en matière d'efficacité énergétique et d'énergies renouvelables et les contraintes de qualité architecturale. Il intervient dans les processus de planification et soutient la prise de décision concernant l'utilisation des technologies solaires.

<u>Mots clés :</u>

Énergie renouvelable, technologies solaires actives et passives, instrument de planification, réglementation environnementale.

Acknowledgements :

I am honored to be one of the recipients of the PAU Scholarship. Thanks to the generous support of PAUWES team and the institution partners, I could accomplish this work.

This thesis would not have been possible without the support of my supervisor Dr. Katharina Franziska Braig and the input of Prof Hassan QUDRAT ULLAH who both took the time to provide feedback throughout the research process.

I would also like to express my gratitude to the ANAAT team for hosting me for 2 months. A special mention to my internship director Mr Mohamed Sghir HADDAR for the valuable support and guidance.

Last but not least I would like to thank my friends Mark MCCARTHY and Hillary CORRIR and my family for providing the emotional support during the research period.

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List of abbreviations

Abbreviation	Meaning
NS	National Scheme “SNAT”
NAPESD	National Action Plan for Environment and Sustainable Development (NAPESD)
DMSC	Development and Management Scheme for the Coast “SDAL”
NASCD	National Action Scheme to Combat Desertification” SDPTD”
RS	Regional Scheme of the Land Use Planning “SRAT”
DSMA	Directing Scheme for Metropolitan Areas “SDAM”
WP	Wilayal Plan of the Land Use “PAW”
MPU	Master Plan of Land Use and Urbanism “PDAU”
CAP	Coastal development plan “PAC”
SOP	Soil Occupation Plan “POS”
EIA	Environmental Impact Assessment
WTO	Word trading organization

Table of concepts :

Concept	Definition
Technology change:	With the notion technology change, we refer to the rate and direction of technology development and its economic impact (Ulli-Beer, S, 2013). Relevant theorizing on technology change can be found within the disciplinary fields of technology and innovation management, industrial dynamics, and evolutionary economics, as well as the systems of innovation literature. The technology change literature is strongly linked to economic growth and competition issues.
Socio-technical transition:	while the notion of technology change is more related to economic growth and competition issues (Ulli-Beer, S, 2013). The Socio-technical transition refers to reconfiguration processes between technology development and broader adjustment processes in science, industry, markets, policy, and culture (Geels FW, Schot J, 2007)that are_necessary for the creation of new trajectories (Geels FW , 2002; Geels FW, Schot J, 2007).Socio-technical system encompass the subsystem of production, diffusion and use of technology (Geels FW, 2004).
socio-technical regime	In the literature the very first definition of the concept was: "... the whole complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, and institutions and infrastructures that make up the totality of technology." (Kemp R, Schot J, Hoogman R). They explain that they refer to rules and beliefs, which "... guide (but do not fix) the kind of research activities that companies are likely to undertake, the solutions that will be chosen and the strategies of actors (suppliers, government and user)."
Governance:	It is a term related to policy interventions and institution building by the government (J, Meadowcroft, 2007). According to (Florini A, Sovacool BK, 2009)), "governance refers to any of the myriad processes through which a group of people set and enforce the rules needed to enable that group to achieve desired outcomes". (J, Meadowcroft, 2007)applies the

	notion “governance for sustainable development.” He refers it to socio-political processes and interactions between public authorities, private business, and civil society oriented toward the attainment of sustainable development. It aims directed and involve the coordination of activities of decentralized actors (Ulli-Beer, S, 2013).

Chapter one: Introduction

Introduction

At the Neolithic age, agriculture and the development of tools led humans to the first stable settlements. This stability helped humans to accumulate surplus. Than appears the necessity to exchange goods by creating markets. By the end of the medieval the printing press boosted exchanging knowledge ending by the Renaissance. Machines enter human life by the industrial revolution witch standardized the production. Cities start facing challenges and urbanism appears as a science to organize the human settlements. Electricity appears in the modern and contemporary word, defining new sense of urbanity and setting new infrastructures.

Nowadays, with the explosion of knowledge and the digitalization expansion the industrialized model of the city need to be rethought.

The United Nations World Cities Report published in May 2016 noted a global trend in which cities have become central to the transformation of the global economy. They can play a crucial role in facing nowadays challenges by being a physical framework for the application of sustainable solutions. Over 60 per cent of global energy demand is consumed in cities . City experts hold the responsibility to response to energy challenges by identifying policy opportunities for reducing the consumption reaching efficiency and exploiting new capacities to generate energy.

It is estimated that half of Africans will be living in cities by 2030 (Smart Africa Secretariat, 2017). Adopting smart cities strategy in Africa will face many obstructions especially concerning the energy sector. Only 39% of the African population has access to electricity . The African cities doesn't have the infrastructure to host such technologies . The low rate of electrification, the luck of connectivity infrastructures, limited energy generation, as the problem of digital alphabetization of African population, are some main reasons making the smart cities inadequately to the African context Furthermore, the centralized vision of smart cities focusing on a specific limited urban centers at the expense of others enhances inequalities between social classes and territories. These are some factors that show the limits of smart cities approach in Africa.

Significance of the study:

Part one:

The reorientation of energy policy is among the challenges of the 21st century Algeria must face. As part of the implementation of this strategy, A National Spatial Planning Scheme "NS" Act was enacted in 2010 and approved for a period of 20 years with sustainable development and economy of resources perspective. The transmission of the national policies to city level is very crucial to insure the effective implementation.

- By what procedures the directives of the NS can be transmitted to city level?
- Where is the gape that blocks the transmission of national policies to city level?

Part two:

Despite the current ambitions in the field of renewable energies, the situation in Algeria, from a regulatory point of view is becoming more and more incentive, but in order to be easy to implement in terms of promoting an environmental architecture that could meet the concerns of sustainable development.

- What is the environmental regulatory framework interfering with the built environment?

Part three:

At a local scale the integration of solar systems in the urban context requires careful planning. Preserve the quality of pre-existing urban areas while promoting solar energy use and enabling cities contributing to renewable energy supply.

- What are the supporting tools and methods ensuring the integration of active and passive solar systems to cities without compromising the architectural quality?

Research objectives:

The aim of this study was to :

- Ascertain the gaps that blocks the transmission of national planning policies to city scale.
- Examine the regulatory framework that refers to environment interfering with the built environment.
- Present samples of qualitative and quantitative tools that can be used by city experts to promote the solar energy in cities without scarifying the architectural quality of the built environment.

Chapter two : literature review

1. The need of Energy Transition :

1.1. Energy and Sustainable Development in Africa:

1.1.1. The United Nations SDG's:

On September2015, after the 2012 RIO+20 United Nations Conference on Sustainable Development the 2030 Agenda for Sustainable Development was agreed by the member states. This Agenda is a plan of action for people, the planet and prosperity. On 11 March 2016, the 47th Session of the United Nations Statistical Commission proposed a global indicator framework for the SDGs, intended as a means to follow up and review progress at the global level towards achieving the 17 goals (UNSTATS, 2016). The 17 Sustainable Development Goals (SDG) are an integrated, indivisible set of global priorities, integrating the economic, social and environmental aspects of sustainable development and recognizing their interlinkages. They are action oriented, global in nature and universally applicable, while accounting for different national realities, capacities and development levels and respecting national policies and priorities (UNEP, 2017).

1.1.2. The African Union Agenda 2063:

The Pan African vision: "an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the international arena (UNSTATS, 2016)." Was redeclared by the African Union (AU) in May 2013. Declaring a in a people-driven process to prepare a 50-year continental agenda (AU, 2016). The results form the basis for Aspirations of the African People, the Agenda's main driver. The Agenda encompasses the three dimensions of sustainable development (environment, economy and society) and has three key components: the vision, the transformation framework and the first 10-year implementation plan. Anchoring the framework are 7 aspirations, 20 goals and 34 priority areas (AU, 2016).

1. A prosperous Africa based on inclusive growth and sustainable development;
2. An integrated continent, politically united based on the ideals of Pan Africanism and the vision of Africa's Renaissance;
3. An Africa of good governance, democracy, respect for human rights, justice and the rule of law;
4. A peaceful and secure Africa;
5. An Africa with a strong cultural identity, common heritage, values and ethics;
6. An Africa, whose development is people-driven, relying on the potential of African people, especially its women and youth, and caring for children;
7. Africa as a strong, united, resilient and influential global player and partner.

1.1.3. Africa-led initiatives to increase access to modern energy

Africa Power Vision (APV)

Agenda 2063 commits Africa to speed up actions in a number of areas, including infrastructure projects related to providing energy. One of the initiatives adopted to stimulate energy sector is the Africa Power Vision (APV), based on the Program for Infrastructure Development in Africa (PIDA). PIDA is the continent's framework to close Africa's vast infrastructure gap across transport, energy and water sectors as well as ICTs. The Africa Power Vision is a long-term plan to increase access to reliable and affordable energy. Its main aim is to drive and rapidly accelerate the implementation of critical energy projects in Africa under PIDA (NEPAD).

The Africa Renewable Energy Initiative (AREI)

It aims to achieve at least 10 gigawatts (GW) of new renewable energy generation capacity by 2020 and to realize the continent's potential to generate at least 300 GW by 2030 (AfDB, 2015). Spurred by the recognition that energy shortages, high costs and poor access remain major impediments to Africa's continued social and economic progress, in 2016, the African Development Bank approved its energy strategy, mainly based on the Bank's new initiative — the New Deal on Energy for Africa (NDEA). The NDEA has an aspirational overarching goal of achieving universal access by 2025. The New Deal directly contributes to achieving the SDGs, in particular, SDG7 on ensuring access to affordable, reliable, sustainable and modern energy for all (UNEP, 2017).

1.2. The linkages between the Agenda 2063 and the SDG's:

SDG goal 7:

It exists strong synergies between the SDG 7" Ensure access to affordable, reliable, sustainable and modern energy for all" with the seventh goal of the Agenda 2063 "Environmentally sustainable and climate resilient economies and communities". AS cited previously the New Deal on Energy for Africa (NDEA) directly contributes to achieving the SDG7 (figure1)

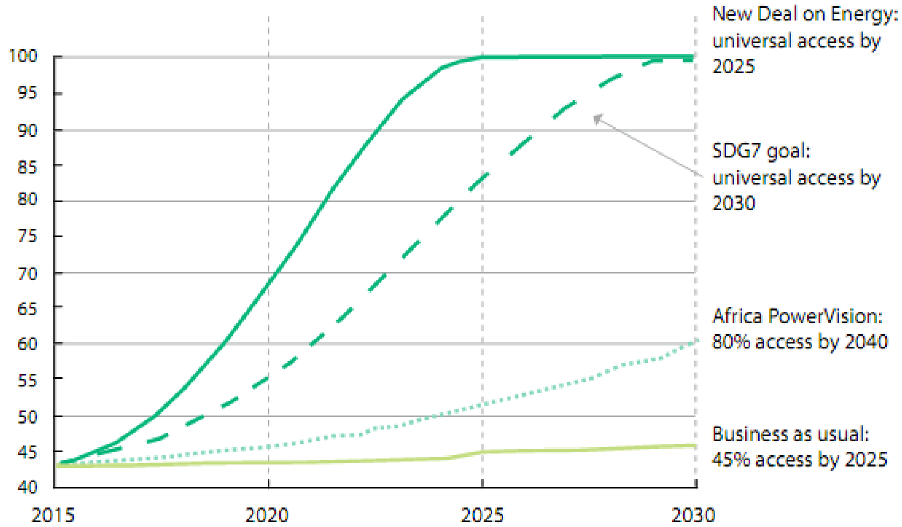


Figure 1 The New Deal's aspirations compared to SDG 7 and the Africa Power Vision (UNEP, 2017).

SDG goal 11:

The spirit of the SDG eleven "Make cities and human settlements inclusive, safe resilient and sustainable" is anchored in the aspirations of Agenda 2063 outlined under its first priority area "A high standard of living, quality of life and well-being for all citizens" (UNEP, 2017).

Habitat III is the United Nations Conference on Housing and Sustainable Urban Development to take place in Quito, Ecuador, in October 2016. It is meant to reinvigorate the global commitment to the implementation of sustainable human settlements and urbanization by focusing on the implementation of a New Urban Agenda. The New Urban Agenda is expected to assist governments in addressing urbanization challenges through national and local development policy frameworks. It will also review UN-Habitat's mandate to ensure that it is fit for purpose and ready to join efforts with governments and stakeholders to promote a new model of urban development for the 21st century (UNEP, 2017) . The Africa Urban Agenda (AUA) is a UN-Habitat initiative designed to raise the profile of sustainable urbanization as an enabler for attaining structural transformation in Africa and the Agenda 2063. With objective of creating partnerships between state and non-state actors in order to promote the formulation of national urban policies. It complements the three pronged approach by putting sustainable urban development within the African context (UNHABITAT, 2015).

There are two projects running concurrently under the AUA:

- The PI (top-down approach) aims to galvanize the commitment of Heads of State in Africa to the potentials of urbanization through calls for prioritization of urbanization as a key element of national and regional development plans.
- The SPP (bottom-up approach) aims to ensure the involvement of non-state actors in forging a sustainable urban environment for Africa (UNHABITAT, 2015).

SDG goal 13:

The seventh goal of the Agenda 2063 “Environmentally sustainable and climate resilient economies and communities”. With Bio-diversity, conservation and Sustainable natural resource management, water security and climate resilience and natural disasters preparedness as priority areas. Is strongly aligned with the SDG goal thirteen “Take urgent action to combat climate change and its impacts”.

The Paris Agreement and the outcomes of the UN Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) held in Paris, on 12 December 2015. A historic agreement to combat climate change and act on and invest in a low carbon, resilient and sustainable future. Participating countries are expected to submit their updated climate plans, called Nationally Determined Contributions (NDCs), every five years, marking a steady increase their long-term ambitions. The INDCs include the following information: (UNFCCC, Press release, 2015 b). Quantifiable information on the reference point (including, as appropriate, a base year)

- Time frames and/or period for implementation
- Scope and coverage
- Planning processes
- Assumption and methodological approaches, including those for estimation and accounting for anthropogenic green house gas emission and, as appreciate, removals.
- To show how the party considers that its IDC are fair and ambitious, in light of its national circumstances and how it contributes toward achieving the objective of the convention (UNFCCC, Press release, 2015 b).

Under the umbrella of mitigating and adapting to climate change, most African countries have developed several intended actions and plans in the energy sector, as illustrated in their INDCs (UNEP, 2017).

2. Energy governance

2.1. Global energy governance:

The rise of global energy governance as a new concept in the field of energy policy, as well as international policy priority issue. Firstly, because it questions the environmental sustainability and the climate change as politically charged concerns. Covering subjects such as the security of energy supply and demand, the functioning of energy markets and price volatility. Secondly, it allows clear understanding of the existing interdependence between the energy systems (an increase in the energy demand in Asia impacts on the energy supply systems of the European Union) to different energy stakeholders (M.Kottari, 2013).

Achieving energy security, widely defined as the ability of an energy system to encompass the aspects of affordability, reliability, security of supply and environmental sustainability (Florini A, 2009). Such an approach requires the existence of institutions that place the rules for this game to be played among governmental and non-governmental actors (Florini A, 2009).

Governance refers to the multiple mechanisms that are used to steer action and processes (M.Davies, 2017) to respond to a certain policy domain within and beyond the state. Energy is a prime example of a sector where public and private interests are in continuous interaction with ongoing controversies and cross-border impacts (M.Kottari, 2013), like the climate change. The notion of governance does not restrict the authority to governmental institutions to impose rules, but enables local actors, civil society and private sector as well, to enhance the regulatory framework.

International institutions play a major role in the energy sector as they could facilitate the functioning of energy markets, lowering the transaction costs, confining their short comings and setting certain rules and standards. In addition, they are limiting the negative consequences of the energy related activities (M.Kottari, 2013).

2.1.1. The Renewable Energy Governance bodies:

a. The International Energy Agency's RE Agenda:

Following the oil shocks of 1973–1974, IEA was initiated by the US government with a main objective to watch the oil market functioning and coordinate the oil reserves amongst its member-states. As an inter-governmental organization limited to OECD countries. With it's IEA's regular publications, like the annually released World Energy Outlook, present the most accurate data for the rest governmental and private actors of the world energy markets thus, it remains the most influencing authority on energy policy and decisions.

Within the context of global energy governance, notably after the establishment of the IRENA in 2009 the IEA to new directions including renewable energy and energy efficiency together with the oil market functioning. Both, IEA's and IRENA's presents of RE data and statistics and expertise sharing in the fields of RE technology and operation. These limited roles do not, really open an institutionalized dialogue about the future of RE further deployment amongst the member-states of the two organizations, nor does it support the active engagement of the RE private actors (M.Kottari, 2013).

Still the role of IEA in renewable energy governance should not be negligible by the submitted reports on energy efficiency an RE policy recommendations eg: Toward a Clean, Clever and Competitive Energy Future (IEA 2007). the cooperation with the United Nations for the recently launched ''Sustainable Energy for All'' initiative, which calls for a global target of doubling the share of RE by 2030. IEA collaborates with the United Nations on this target's baseline definition and progress monitoring (IEA, World Energy Outlook 2012) (M.Kottari, 2013).

b. International Renewable Energy Agency (IRENA)

IRENA is the first intergovernmental institution created in order to provide exclusive diplomatic and technical support for RE deployment globally. IRENA came to life on 2009 after the founding conference on International Renewable Energy 2004 taken place in Bonn Germany. With a priority of the creation of an advisory, information exchange and capacity—building support framework for the governments to enhance their decision- making and technical capacity in RE sector (M.Kottari, 2013). IRENA comes with important shortcomings; its budget is modest, its functions are not clearly defined and the adoption of UN governance procedures, especially the consensus rules about decision making, may generate obstacles in IRENA's vision to lead the way towards a more RE oriented global energy market (M.Kottari, 2013).

As we have stated previously, the IEA, while trying to preserve its "prestige" in the international energy arena , IEA has set an important refom in its structure Division with specialized RE staff, including RE energy production perspectives in its future energy scenarios and finaly in 2011, IEA published a study book entitled ''Deploying Renewables: Best and future Policy Practice'' (IEA 2011) (Van de Graaf T, 2012).

c. Renewable Energy Policy Network for the Twenty-First Century

REN21 is an international and multi-stakeholder network, based in Paris, aiming at the promotion of RE through the connection of a wide range of public and private energy actors (M.Kottari, 2013). It aims to be an exchange platform of RE stakeholders in order to assist, legislators and private energy actors in the establishment of RE regulations and standards. REN 21 releasers global and future status reports about RE market, industry and RE policy updates. These actors are governments and international organizations but also industry associations, academia and civil society. A major achievement is Renewables Interactive map, an online research tool offering an updated picture of RE developments global status. Finally, REN21 organizes of International Renewable Energy Conferences (IRECs), hosted by alternate governments every 2 years, gathering governments, private sector and NGOs engaged in high-level dialogue on RE field. REN21 is an excellent t RE global governance coordination with it's interactive platform while it lacks a decision making structure.

d. Renewable Energy and Energy Efficiency Partnership (REEEP):

REEEP is a UK initiative gathering 358 member organizations including NGO's, governments, industry associations and banks. It was launche in 2002 at Johannesburg World Summit on Sustainable Development (WSSD). As a non-governmental organization with a main focus on the reduction of greenhouse gas emissions and the acceleration of global market for sustainable energy primarily in developing and emerging countries markets (Parthan B).

The flexible, structure of REEEP compared to the international governmental organizations, the engagement of RE public and private actors, which, however has downsides, and its applicability to a smaller scale compared to IEA or IRENA (Sovacool B, 2011): differentiate the agency from other global energy players.

2.2. Algeria energy governance:

Algeria is an active member in the OPEC, OAPEC however it doesn't accept these organizations as an actor in the internal energy policy of the country (Kumetat, 2012) (IRENA, 2011). The country has signed the initial IRENA statute during the initial Bonn conference on 26 January 2009((IRENA, 2011)), Algeria's instrument of ratification was only deposited on 09 May 2012 ((IRENA, 2011)). IRENA role in the Algerian energy decisions is very limited (Kumetat, 2012).

2.2.1. The institutional energy governance bodies:

Added to the MEM, SONATRACH and SONELGAZ the energy sector in Algeria presents several institutional energy governance bodies:

- NEC - The National Energy Council (Conseil national de l'énergie). Established through the presidential decree n°95-102 (8 April 1995), the NEC is charged with supervising and controlling Algeria's long-term national energy policy. The NEC represents the top-level energy body in the country and is presided over by the President of the Republic. Other members include leading Algerian energy officials such as the ministers of defense, energy finance, the Algerian central bank governor, and the head of the national planning committee.

- CREG – The Regulatory Commission of Electricity and Gas (Commission de regulation de l'électricité et du gaz). The national regulatory framework has been defined by law n°02-01 released on 5 February 2002. Articles 132 and 133 form the legal basis for the CREG. Apart from the standard tasks of a regulator body, this commission observes and enforces the transparency of electricity markets and the well-functioning of a healthy competition. It releases national electricity targets and detailed plans of how renewable power is to be integrated into the national energy system.

- CDER – The Centre for the Development of Renewable Energies (Centre de développement des énergies renouvelables). Founded in March 1988, the CDER is the best-known renewable energy research institution in Algeria. It focuses mostly on R&D programs focusing on solar, wind, geothermal and biomass energy. The headquarters of the CDER is based in Bouzareah, in the outskirts of Algiers, but further research and development units are deployed in the oasis of Ghardaia, in the coastal city of Tipaza and in the desert town of Adrar. While the CDER could potentially be a significant institution in Algeria, it has very limited funding and political influence, mostly because it is not an organizational part of the MEM, but rather a pure research institute under the tutelage of the Ministry of Higher Education and Research.

- New Energy Algeria (NEAL) was founded in 2002 as a subsidiary of the Algerian energy incumbents Sonatrach (45%) and Sonelgaz (45%) with 10% extra capital from the private investor SIM (UbiFrance, 2010b). The task of this start-up is to foster and develop any kind of renewable power production in the country.

- In many ways, the IAEREE – The Algerian Institute for Renewable Energy and Energy Efficiency (Institut algérien des énergies renouvelables et de l'éfficacité énergétique) can be regarded as an institution competing with the CDER. Although only founded in 2009, the IAERE finds itself in a much better starting position as it belongs to the MEM. The institute will be established in the district of Hassi R'Mel. It is designed to interact closely with the national renewable energy company New Energy Algeria (NEAL) and other energy companies.

- APRUE – The Algerian National Agency for the Promotion and Rationalisation of Energy Use (Agence nationale pour la promotion et la rationalisation de l'utilisation de l'énergie). Originally created in 1985, this institution has been restructured by law n°99-99 on energy efficiency on 28 July 1999.The APRUE is institutionally weak, but represents efforts to work on demand side management in Algeria.

- The diversity of intuitional governance bodies reveals the countries commitment toward the development of renewable energy.

- The institutions sited before are directly or indirectly state runed.

- The absence of independent NGO and CSO acting on the field leaves a free arena to the state elite energy players.

2.2.2. Climate change and the birth of the ministry of Environment and Renewable Energy:

Water scarcity is the main climate change challenge that can face Algeria. Water desalination efforts will increase the emissions and accelerate climate change. Renewable energy would be an excellent solution to meet the energy demand while cutting the emissions. While the energy sector is the main GHG emitter (Kumetat, 2012), climate change was not strongly mentioned on the 2011 renewable energy program. In 2009 the national agency of climate change ANCC was established but still remains understaffed and institutionally weak (Kumetat, 2012).

On May 2015, a partial governmental change terminated the tasks of The Ministry of Land Use Planning, Environment and Tourism. Environment was associated to The Ministry Of Water Resources .Two years later, a dedicated ministry to environment directly associated to renewable energy was created . The aim behind the association of renewable energy to the environment might be the solicitation of external funds of support to climate change mitigation agenda (Rebah, 2017). But without the financial resources of SONATRACH and SONELGAZ and the technical and managerial expertise in the domain of energy the renewable energy program face the risk of failure known that the renewable energy and energy efficiency program was issued by the Ministry of Energy and Mines.

2.2.3. Conclusion

Despite its membership to many global energy bodies, their influence on the Algerian energy policy is very limited. However, the EU climate mitigation agendas and the dynamic renewable electricity markets are not without effect on the internal energy policy the 10GW exportation capacity in the RE program is a best indicative of that. Around and across the Mediterranean regionalism is on the rise. The renewable electricity is not mentioned on such cooperation yet, the stability of the grid can help the introduction of renewable resources in the future.

Algeria adopt the republican governance but still modeled under the inherent French system. It is a centralized model of governance concentrated in the capital Algiers. Thus, energy policy is being performed of a top down model. The decisive ministries are mostly stuffed with representatives of SONATRACH and SONELGAS. Which explains the domination of the oil and gas industry on the design of the energy policy of the country. The centralized system does not grant any autonomy to local provinces" wilaya" in term of decision making. Since their governors are directly appointed to the president. As a consequence of this big centralization, the bottom up innovations of the sector are hardly accepted. The government and the oil and gas elites should never be crossed during policy formulating. They are potent players that can even block policy initiatives. The policy initiatives are either imported from outside or domestically developed but with the bureaucracy processes it is rarely occurred.

Additionally, the absence of NGO or CSO involved on the domain means that there is no external agenda practicing stress on the ruling politicians. Renewable energy is not democratized in the country despite the great role that it can play in enhancing the political stability and the security of country with the economic benefits and the labor market potential of the industry.

Energy sector is the main emitter sector in the country. Desalinations activities and water shortages on the country are directly related to climate change. However, the phenomenon is not mainstreamed by the renewable energy program. Education and religious channels can be very effective in creating public awareness about the alarming status the faces the planet.

3. The socio-technical transition theories:

The socio-technical transition towards sustainability or also called sustainability transition research focuses in understanding how shifts in societal undesired trajectories of technological developments towards more sustainable trajectories come about in sectors (Kemp R, Schot J, Hoogman R). It claims the importance to implement all sustainability trilemma societal, economic, ecological in the socio-technical governance mission (Ulli-Beer, S, 2013).

This development has been inspired by different research strands that include research on technological paradigms (G, 1982),on technological regimes (Nelson RR, Winter SG, 1977)complex system research (Kauffman S, 1995)and national innovation systems research (Freeman C, 1988), as highlighted by (Markard J, Raven R, Truffer B, 2012). The authors have identified the following four core research strands in the field of sustainability transitions studies: transition management (TM), strategic niche management (SNM), multi-level perspective (MLP) and technological innovation system (TIS). The authors also highlight that, for the maturation of the field of sustainability transitions studies, it becomes important to reach out beyond these approaches.

In the field of sustainability transitions studies, the literature has identified the following four core research strands: transition management (TM), strategic niche management (SNM), multi-level perspective (MLP) and technological innovation system (TIS) (Ulli-Beer, S, 2013).

3.1. National System of Innovations (NIS):

A system perspective emphasizes interactions between technology, actors, institutions, and activities beyond the boundary of the firm (Geels FW, 2004).
(Freeman C, 1988)defined the term national system of innovation as “the network of institutions in the public and private sectors whose activities and interactions initiate, import, and diffuse new technologies” (C, Freeman, 1987). With the term activities, he refers to education, training, production engineering, design, and quality control, as well as R&D. These activities are organized by institutional arrangements, such as research councils, national R&D labs, or universities (C, Freeman, 1995).

(Edquist C, 2004) provides a broader and more general definition of (national) systems of innovation: “all important economic, social, political, organizational, institutional and other factors that influence the development, diffusion and use of innovation.” He points out that, at the present state of the art, the determinants of innovation are not understood systematically and in detail. This has laid the ground for further NIS research that focuses on the broader contextual factors and relationships that support technological change. For example, the “triple helix” of the university-industry-government relationship has been focused on as an important contextual relationship that supports innovation and economic growth (Etzkowitz H, Leydesdorff L, 2000). Recent research has focused on factors that explain distinct patterns of technology-based sectoral change (Dolata U, 2009). The transformative capacity of a new technology has been suggested as one factor that describes the technology-based pressure for change. The complementary factor is the sectoral adaptability that accounts for the variance in the ability of social subsystems (e.g., institutions and actors) to anticipate and proactively manage technology pressure (Ulli-Beer, S, 2013).

The innovation systems approached focus on factors and interactions supporting technology-based entrepreneurship. It provides clear understanding of the competitiveness of effective structures in innovation systems. Therefore, the traditional innovation system approach may be considered as multi-dimensional variance theory. It does not address dynamic aspect, neither concerning the evolution of structures nor system behavior (Ulli-Beer, S, 2013).

3.2. Technological Innovation System (TIS):

This approach focusses on technological niche development (Jacobsson S, Bergek A, 2004). It aims a better understanding of the processes and their dynamics in the buildup of innovation system.

This literature assumes that the innovation system around a technology is crucial of technological change. The development of the technology under chronological sequences is required for the deployment of cleaner technologies. Examples of such functions are entrepreneurial activities, knowledge development, knowledge diffusion, guidance of search, market formation, resource mobilization, and creation of legitimacy (Hekkert MP, Suurs RAA, Negro SO, Kuhlmann S, Smits REHM, 2004)). A weak performance of a function or a miscoordination between different functions may cause the failure of the eco-innovation system.

This research tries to identify patterns of reinforcing interactions between the functions, named motors that foster the development of the functions (Ulli-Beer, S, 2013). With their approach, they provide the characteristics of a conceptual description framework, but does not yet qualify as a causal explanation for the emergence of structure and system behavior (Ulli-Beer, S, 2013). Yet, it does not suggest a causal explanation about structural conditions that motor the performance of functional achievements. Any institution- and actor-specific dimensions are missing, as well as causal incentive or pressure concepts (Coenen L, Dıaz Lopez FJ, 2010)

3.3. The Transition Management Theories (TM):

Transition management researchers use conceptions such a technological and market niches and how they enable shifts in socio-technical regimes (Kemp R, Schot J, Hoogman R). It includes interactions between institutions, a network that “creates the structural patterns that shape innovation and creates trajectories of social development” (Smith A, Voss J-P, Grin J, 2010).It aims to give a suitable governance framework to manage sociotechnical transition by mixing short and long term processes at various levels. Four types of governance are defined by this research stand : Strategic, tactical, operational and reflexive, which are deemed necessary for optimizing sociotechnical transitions (Kemp R, Schot J, Hoogman R).

Strategic: On this level long term visions and goals are defined and specified (Loorbach, 2010). A central aim is the integration of long term planning into short term political cycles. Processes on this level are long term of about 30 years (Loorbach, 2010).

Tactical: On this level tactics for reaching the overall visions and goals are established in sociotechnical subsystems i.e. patterns and structures such as rules and regulation, and concerns institutions, organizations, networks infrastructures and routines. Processes on this level are midterm of about 10-15 years (Loorbach, 2010).

Operational: On this level practices are established, mainly on a local scale as operational activities, experiments and actions, often carried out in the context of innovation. This is done by introducing structures, culture, routines or actors often over short timeframe of about 0-5 years (Loorbach, 2010).

Reflective: On this level learning effect ensures transparency and prevents lock in to suboptimal paths. This is done by monitoring, assessing and evaluating through; scientific contribution, responsible entities and actors, media topics. Processes on this level are continuous (Loorbach, 2010).

For this research, an optimal transition needs an integration of all levels of governance a circular approach and a continues learning process (Loorbach, 2010).

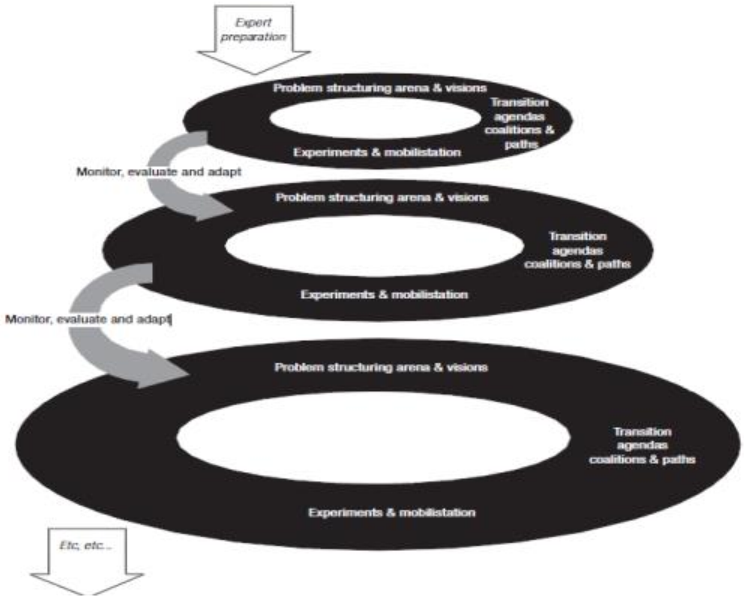


Figure 2:The Transition Management Cycle (Loorbach, 2010)

3.4. The strategic niche management theory (SNM):

The SNM is a research model and a policy tool for the socio technological change appeared on to lead by (Loorbach D, 2010). It focuses on the description and leading to recommendations on specific issues at micro or meso level (Loorbach D, 2010). It carries innovation single experiments so they can act like building blocks ”niches” for societal change towards sustainable development (Geels FW, Schot J, 2007).For SNM five factors are understood as significant:

Expectations and visions: Having a clear definition of expectations and visions shared by multiple stakeholders offers a direction to the innovation and attracts attention. It legitimates (continuous) protection and nurturing of the innovation (Schot, J., & Geels, W. F, 2008).

Learning: Ensuring broad learning effect of multiple dimensions with accumulation of data and facts, as well as ensuring facilitation of changes in the cognitive frames and assumptions surrounding a project i.e. second order learning (Schot, J., & Geels, W. F, 2008).

Networks: Including many different actors with possibility to mobilise resources and commitment in other networks and organisations. It ensures diverse viewpoints and experiences (Schot, J., & Geels, W. F, 2008).

Protected space: Creating protected spaces where experimentation can be carried out in a way that ensures coevolution of technology, user-practises and regulatory structures. This can enable development of the project until it is ready for market penetration (Schot, J., & Geels, W. F, 2008).

Niche-regime interaction: Innovation will have to fit well with the received context. Taking a multilevel approach that ensures that the project is relevant in providing solutions or functions otherwise missing in the sociotechnical regime (Schot, J., & Geels, W. F, 2008).

3.5. Multi-Level Perspective (MLP):

Multi-level governance theory aims to provide an analytical tool to capture sociotechnical transitions (Kumetat, 2012). It focuses on changes in institutional structures and actor networks over time. It is a multi-level approach that distinguishes three layers for socio technical change: the niches (micro), regime(meso) and landscape (macro). These levels are note hierarchical but an integrated network of interactions between actors and various decision-making bodies pushing towards or stopping a certain development path.

The Socio technical regime is the key level of analysis for the MLP. The ST regimes occupy a key role at the modern societies. It contains the “grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures…ways of defining problems; all of them embedded in institutions and infrastructures” (Rip & Kemp, 1998, p. 340). The ST interacts with a number of different ST sub regimes trough mutual interconnections and social systems.

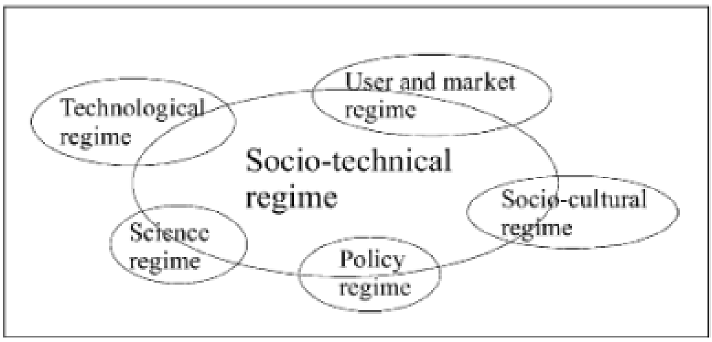


Figure 3:Actor systems in socio-technical regime (Geels FW, 2004)

Conclusion

The socio-technical transition research strand provides many conceptual frameworks. Remaining the challenge of choosing the most suitable to a specific real word situation (Ulli-Beer, S, 2013). (Coenen L, Dıaz Lopez FJ, 2010)have identified substantial conceptual differences between sectoral innovation systems, technological innovation systems and the MLP approach on socio-technical systems. Major conceptual differences reveal regarding the delineation of system boundary, and the conceptualization of actors, networks, institutions, and knowledge (Ulli-Beer, S, 2013). It was concluded by the literature that these differences hinder knowledge integration for the investigation of drivers and barriers of sustainability transitions and improved competitiveness in socio-technical systems (Ulli-Beer, S, 2013).

4. Algeria energy policy analysis using MLP theory:

Algeria rich energy resource country (fossil, renewables) shaped by its war of independence 1954-1962 and it’s “black decade” 1990-2000. Heavily dependent on fossil exports Alegria should prepare for a post hydrocarbon era. The ministry of energy and mines has a key position in the country since it directs “SONATRACH” the national oil producer. In 2009 the company has generated 98% of Algeria foreign currency revenues (Mebtoul, 2010) . SONELGAZ the national electricity utility is the dominant player on the electricity market. It produces 87% of electricity and owns the national power grid. The grid system is well developed in the north of the country but still failing in the south due to economic, climatic and population density factors.The off-grid PV or less frequently CSP as renewable energy programs in rural electrification. This chapter introduces analytical dimensions of renewable energy policy in Algeria using the multi level perspective theory. The purpose is to present key elements of energy policy in the country to be able to define potentials opportunities and barriers of the deployment of renewable energy in the country.

4.1. Landscape level

• Political system	• Algeria has a republican model of governance which means that there is no second structure in decision making except the elected body. • Informally a second strong authority structure that has political and economic interest justify the close door decision making in the country the luck of accountability and transparency and the unjustified block of some development trajectories (Kumetat, 2012). • The energy policy sector is very much centralized on the capital Algiers and mainly dominated by the ministry of energy and mines, SONATRACH and SONELGAZ and the Oil and Gas elites. • The techno-regulatory innovations of the sector are either to be imported from the abroad or to be nationally developed but both blocked by the Algerian bureaucracy. • A top down model ruled by the oil and gas and military elite. • The renewable energy industry represents a marginal interest to the elite of the sector. •
• Regional electricity governance bodies	• Algeria is not only a part of the inter Maghreb and North Africa governance bodies COMELEC but also a part of the EU trans-Mediterranean governance groups MED-EMIP (Kumetat, 2012). • MED-EMIP main goal is to create a trans-Mediterranean grid that enables power flows around and cross the Mediterranean. • The inter Maghreb power grid allows power flow in demand peak situations. • However, the emergence of an electricity market in the region is constrained by the difference in electricity prices. • These cooperation agreements target to strengthen the regional grid but does not mention any focus on renewable energy. • The cooperation help stabilizing the grid through which can help in the future a more intermittent renewable electricity in the system. • The EU climate mitigation agendas and the dynamic renewable electricity markets are not without effect on the Algerian energy policy the 10GW exportation capacity in the RE program is a best indicative of that. • Most of bi directional trans Mediterranean electricity exchanges are either based on coal (North Africa to EU) or nuclear (EU to North Africa)
• Climate change	• Water scarcity is the main climate change challenge that can face Algeria. Water desalination efforts will increase the emissions and accelerate climate change. Renewable energy would be an excellent solution to meet the energy demand while cutting the emissions. While the energy sector is the

	main GHG emitter (Kumetat, 2012), climate change was not strongly mentioned on the 2011 renewable energy program. • In 2009 the national agency of climate change ANCC was established but still remains understaffed and institutionally weak (Kumetat, 2012).
• Economic diversification	• Algeria has a quasi total dependence on hydrocarbons 97.7% of share of its exportation 2007 (Kumetat, 2012). • Prepare of an alternative source of income after the fossil fuels era is the highest priority. • In absence of clear economic long-term strategies for the country the basis of the development of renewable energy industry remains weak (Kumetat, 2012). • The scenario of remaining an energy exporter country is highly voiced (Kumetat, 2012)the 10 GW in the RE Program is a big step toward this ambition. But the implementation framework is still to be met. •

4.2. Regime level

• Technological regime: •	**The nuclear alternative :** • Algeria has a considerable deposit of Uranium which are not being exployted and has developed and advanced nuclear activity. • Algeria owes one of the most advanced nuclear energy complex in the MENA region (Kumetat, 2012). • Algeria's nuclear energy research is mainly conducted in two centres, the Centre des Sciences et de la Technologie Nucléaire (created in 1976) and four regional centre under the auspices of the Commissariat pour l'Energie Atomique (COMENA); an agency created in 1996 that directly reports to the Presidential Palace (International Institute for Strategic Studies,2008). • Since 1974 Algeria has considered the possibility of nuclear power generation to save fossil fuel reserves for exportation the program was launched in 1981. • The program considered four facilities on two sites: the Nur research reactor and a fuel-fabrication plant at the Draria nuclear complex 20km east of Algiers. Notably, the former 1MWt light water reactor that went critical in 1989 has not been a turnkey operation (Hadji, 2016). • The second major nuclear site of the country is the Es Salam (Arabic: "Peace") research reactor in Ain Oussera 140km south of Algiers. A 15MWt heavy water reactor was built by a Chinese contractor in line with an Algerian-Chinese nuclear cooperation treaty signed in the 1980s. Owned By the Ministry of Science and Higher Education, It went critical in 1992 (GlobalSecurity.org, 2012). • Unlike renewable the nuclear power sector does not have a strong supporting lobby.

	• At the present time, the nuclear energy plan appear far as neither the uranium mining begun yet, nor has the current nuclear impasse with Iran, nor the Fukushima disaster helped furthering the cause for an Algerian nuclear program (for a critical newspaper article in the post-Fukushima period, 2011). **<u>Shelling alternative:</u>** • Algeria holds the third largest shale gas resource in the world. (Kuuskraa). • In January 2013, the Algerian parliament approved amendments to hydrocarbon laws that introduced strong fiscal incentives to attract foreign companies to explore the country's shale resources (U.S. Energy Information Administration, "Algeria Analysis Brief."). • In May 2014, the Algerian cabinet announced it will move forward with the exploitation of the country's large shale reserves. (Casper Star-Tribune Online, 2014) • The constraints of shelling are numerous: the risks due in its • Exploitation , particularly the pollution generated by hydraulic fracturing and also the increased risk of earthquake; the scarcity of water resources and the high cost of such investments. (CHEBIRA & AMIRAT, 2017) -
• User and market regime: •	**<u>RE market regime and the double subsidies system:</u>** • In 2002 Algeria releases a law on electricity and gas distribution liberating the power market and incentivizing the construction of renewable energy power production by paying premiums and tax reduction to power producers which is very similar to the German renewable energies act EEG. Two years later, a decree introducing Feed in Tariffs for renewable electricity production (Industry, 2009): • Solar power stemming from combined-cycle plants is paid a premium of 100% and up to 200% of the standard electricity rate, depending on the share of solar energy in the project, which needs to be at least 5% of the total production of the power plant • Electricity from waste receives 200% of the standard rate • Electricity generated by hydropower receives a 100% premium • Wind power is remunerated with 300% of the KWh-rate • A "pure" solar power plant receives 300% of the standard rate • Cogeneration through steam or hot water receives 160% of the standard rate, as long as the overall capacity does not exceed 50MW • With the introduction of the renewable energy law cited before Algeria processes the most advanced renewable energy law in Africa and the Arab word (Kumetat, 2012). However, the implementation of the law is still far to be

	implemented; due to the administrative block and the power market barriers. • In 2010 the national fund on renewable energy was established these funds are generated by 0.5 percent tax on oil revenues (Hadji, 2016). • Algeria spend around 6.6% of GDP on energy subsidies (Kumetat, 2012). As a result, no electricity production can compete on the regular electricity market. The energy stakeholders voiced very pessimistic views regarding the removal of the subsidies in the immediate or midterm future (Kumetat, 2012). • the only solution to promote renewable electricity in the power market is the integration of the renewable electricity on the governmental subsidy schemes. • Such decision has been made by the MEM.
• Socio-cultural regime:	**RE and labor market potential:** • Public sector is dominating the renewable energy jobs “research centers and universities”. Whereas in the recent years we have considered the arising of some semi private NEAL and private companies Condor, Groupe Cevital. • The implementation of RE program will initiate further employment dynamics: two hundred thousand jobs in the Algerian renewable energy by virtue of 65 planned projects (M, 2011). • Regarding the situation of the implementation of theses plans it remains doubtful whether the Algeria labor market will profit from that desired extent((Kumetat, 2012)).
• Policy regime	**The renewable energy program 2030:** • The expanse of local power demand and the proximity to the European Union are the main incentives to renewable energy policy in Algeria (Kumetat, 2012). • In February 2011, the MEM launched an ambitious program to produce 22 000MW of electricity from renewables with 10. 000 MW for exportation. With a target of 20% of electricity generation from renewables by 2030 (Algeria Renewable Energy and Energy Efficiency Development Plan 2011-2030, 2019). • Self-sustainable solar industry was the flagship aim of the program other renewable resources where neglected due to the small their small capacity compared to solar. • The program is divided into 3 stages: • 2011 – 2013: pilot projects and testing period for various technologies with a goal to install 110 MW of RE power capacity

	• 2014 – 2015: beginning of the deployment program. Installed RE power capacity to reach 650 MW by the end of this period; • 2016 – 2020: large scale REs plants deployment. Installed power capacity to reach about 2600 MW the end of this phase. • If successfully implemented , the plan forecast 37% of total nationalpower production by 2030. • In 2015 an updated version of the program was adopted with 45000 mw until 2020 and 22.000 MW until 2030 split as follow (Algeria Renewable Energy and Energy Efficiency Development Plan 2015-2030, 2019): • Solar PV : 13 575 MW • Wind : 5010 MW • Solar thermal : 2000 MW • Biomass : 1 000 MW • Cogeneration : 400 MW • Geothermal : 15 MW • If the above capacity target will be achieved, renewable generation share in total power generation of Algeria will reach 27%. • The review of the Plan puts greater focus on deployment of large-scale solar PV installations and onshore wind due to large technology costs decrease as well as introduction of biomass, cogeneration and geothermal technologies into the mix until 2020. CSP technology will be deployed with a delay due to still high technology costs.

4.3. Niche level

• Technological developments	• Algeria has a significant solar potential for CSP or solar PV for off grid rural electrification especially in the big south. However, the abundant presence of natural gas at very low prices is a major obstacle that faces the development of such technologies. • Besides the electricity production solar desalination (Bouchekima, 2002) and solar cooling are very promising options that Algeria can deploy (S. Mekhilef, 2011).

• The social acceptability of RET:	• The Algerian public and stakeholders are aware of the huge potential of renewable energy in the country due the governmental complains conducted by some institutional bodies. However, a real touch with RE technologies remain limited. • The RET are not yet integrated to the educational agenda (Kumetat, 2012). • Religious parts such as mosques can play a several roles in the awareness about climate change effects and how RET can mitigate the damages however RET are marketed as an environmental ethics rather than a religious value. • The awareness should start by using such technologies in public institution and give a tangible example to the society.

4.4. Conclusion:

Algeria is a wealthy state in term of renewable and non-renewable energy resources. A rationalized use of this wealth is a must.

An economic preparation for the post hydrocarbon era has always been the first priority for the Algerian authorities. The actual quasi total dependence on fossil exports threat the security of the country.

The energy sector is dominated by the oil and gas elites.

The decision making follows a centralized bottom up model of governance characterized by the luck of transparency and accountability. The declarative energy policy focusing on regulative change and the luck of monitoring of the implementation are major reasons justify the successive failures of the multiple energy programs.

Remaining an energy exporting country throughout a resource diversification has always been a voiced scenario.

The nuclear program could not be achieved. Actually, with the international security conditions the nuclear alternative is far to be achieved for the near- or medium-term future.

Despite the environmental externalities and the social rejection of the unconventional resource exploitation, shale gas still seems promising since it is supported by the oil and gas lobbies.

Renewable energy reveals as an optimum solution for the post hydrocarbons era. The advanced research and technologies, and the ambitious programs confirm the commitment of the government toward renewable energies. The ambitious RE and EE program confirm the scenario of an energy exportation.

Chapter three: Research Methodology

The thesis has employed a qualitative method research design in enrolling the study. A document analysis technique was used. Hence, a detailed analysis of Algeria energy policy and governance situation using the multi-level perspective method was presented as literature review.

Then, legislative arsenal and planning instruments was collected from key institutions to obtain detailed information about existing rules concerning territory planning, environment protection, the building sector and renewable energy. The evidence collected has been subject of critical analysis.

At a first stage, the thesis held a global approach analysis of the different urban planning and environment protection instrument. The aim behind is to localize the gape that blocks the transmission of national policies to city scale.

Focused on the architectural scale, a second analysis examined the legal framework that refers to environment interfering with the built environment addressing the sun, light, wind, air, noise, lighting, thermal comfort, energy. To cover all the aspects of the legal arsenal an obvious and hidden content analysis was applied. The first section treated the building sector while the second concerned renewable energy and energy efficiency preoccupations.

A list of shortcomings and challenges of the existing regulatory and instrumental framework was established. This list of factors was then used to identify the need of improvement on the planning instruments. Then generate recommendations and guidelines for a successful integrated solar energy in architecture and urban planning process.

The last part was a presentation of collected qualitative and quantitative methods of quality integration of solar technologies on urban planning.

Chapter four: results and discussion:

1. Instruments and tools of urban planning:

According to the Ministry of Land Use, Environment and Tourism of Algeria, nearly 45% of the population still live on an area of 30 million ha. The majority of this area is concentrated in the coastal zone by less than 2% of the land area while the rest of the country is practically empty (Union), 2010). This has prompted authorities to create and implement a battery of tools. Composed of four levels covering the whole country and dividing it into homogenous zones on the basis of several factors: socio-economic, cultural, potentialities and perspectives of the development, technics, geomorphological. (General Secretariat Government , 2001). In order to design and implement a coherent development of the entire territory of Algeria, from global to local level in the framework of sustainable development. These updates came to correct the former ones before 1990 and ignores these sittings and considered only the administrative ones (Gherbi M, 2015). Supposed to be based on sound analysis and cross-sectional studies, these instruments are flexible with the possibility to adapt desired trajectories of development for long term 15-20 years (Gherbi M, 2015).

The large sensitive areas such as the coastal front and the highlands, are supervised by special schemes: DMSC and NASCD (Gherbi M, 2015).

The regional scale and the third level are formed by the RS. The WPs still have ambiguous status because they are marginalized and the DSMAs only concern large and important cities like Algiers, Oran, Constantine and Annaba (General Secretariat of Government, 1990).

the MPU as SOP represent the fourth level of the instrumental hierarchy [(General Secretariat of Government, 1990)]. The SOP acts under the direction and guidance of the MPU and within the perimeters that it defines.

Based on the administrative division as limit of his intervention; The MPU concerns the space of the commune. As it concerns inter-communal scale as well, when the issues and common interests of the municipalities concerned are necessary either inside the communes of the same wilaya or of different wilayas (Gherbi M, 2015).

1.1 The National Scheme (NS) 2030:

The National Spatial Planning Scheme “NS” 2030, which focuses on five key areas - industry, environmental protection, agriculture, renewable energy and water - is an act by which the State displays its territorial project. Integrated in a context of globalization and competitiveness, this program aims at the integration and the influence of Algeria in its natural areas of belonging and evolution in the Maghreb, Euro-Mediterranean and Africa regions.

The ministry of Territorial Planning, Tourism and Crafts believes that the NS program is a tool for the development of programs that will address citizens' concerns, including food security, the availability of water and energy resources and the development of industrial activities. In the medium term, the public authorities aim to achieve sustainable development that ensures that Algeria is less dependent on hydrocarbon revenues.

The National Land Use Planning Scheme (NS) is an act by which the State displays its territorial project. The NS shows how the State intends to ensure, within a framework of sustainable development, the balance, equity and attractiveness of the territory in all its components including national defense and security, as set out in Article 5 of Law No. 01-20 of 12 December 2001 on sustainable land use planning and development.

The NS is based on three fundamentals with three deadlines:

- the demographic deadline: it is perfectly programmed with the arrival of the bulk of the wave of job seekers.

- The economic outlook: competitiveness and the upgrading of the territories as a corollary. It is the creation of the free trade area and the entry into the WTO.

- The ecological deadline: which requires the preservation of natural and cultural capital in a situation of water stress and scarcity of soils and where competition is increasingly strong between use and sustainability of resources.

Six major stakes are identified on the document:

1. Compensation for the natural and geographical handicaps of regions and territories in order to ensure the balanced development, development and settlement of the national territory.

2. The correction of inequalities in living conditions, through the diffusion of public services, the fight against the causes of marginalization and social exclusion, both in the countryside and in the city.

3. Support for economic activities according to their location, distribution, strengthening and dissemination throughout the territory.

4. Control and organization of urban growth.

5. Correct territorial and sectoral development imbalances arising from natural geographical and climatic constraints.

6. Remedy the trends of changes inherited from the past and implemented by man.

Four guidelines to insure the implementation of the NS

1. The sustainability of resources;

2. The rebalancing of the territory;

3. The attractiveness and competitiveness of the territories;

4. Social and territorial equity.

The architecture of the NS 2030:

Composed of 17 thematic reports and a graphic document in several scales, the NS is robust around:

- 20 Territorial Action Programs TAP

- 19 Schemes Sector Managers SD

- 09 Regional Land Use Plans RS

- 04 Metropolitan Area Development Guidelines DSMA

- 48 Wilaya Development Plans (WAP)

The NS 2025 is implemented in two phases:

- A first phase 2007-2015: during which the spatial planning policy will remain during this period mainly marked by voluntary action of the State. It is the immediate implementation phase of NS 2025 through the nineteen (19) Master Plans for Major Infrastructure and Collective Services of National Interest.

- A second phase 2015-2025: this is the partnership phase, during which, the State having implemented the structuring investments of its spatial planning policy, will increasingly play a role of regulator and arbitrator, leaving opportunities for important actions to a wider range of actors.

1.2. The master plan of urbanism MUP and the Soil Occupation Plan SOP:

The MUP (the master plan of development and urbanism) and the SOP Soil Occupation Plan are the planning instruments defined by the Algerian regulations in force. The concept of urban composition is strongly present, and attention to architectural details does not show any absence either. This constitutes the main advantages of these instruments as regulations. The MPU and SOP offer the possibility of integrating complementary, or even specific, regulations that could encompass environmental and energy aspects.

In Executive Decree No. 91-175 of 28/05/1991 defining the general rules for planning, urbanism and construction (JORA No. 26, 1991), this possibility is clearly stated.

Article 25, part of Chapter I on the general rules for planning and urbanism (JORA No. 26, 1991, p.792) , stipulates that “derogations from the rules laid down in this chapter may be granted by order of the Minister responsible for town planning after receiving an opinion or on a proposal from the territorially competent Wali.

- On a permanent basis, for certain regions, in particular the southern part of the national territory, as well as for constructions situated in classified urban fabrics or those having a specific character.
- Exceptionally, especially for buildings with an innovative character.

This is also the case with Article 35 of Chapter II, which stipulates the general construction measures applicable to residential buildings:” Each room shall be lit and ventilated by means of one or more openings, the whole of which shall be at least one-eighth of the surface area of the room. ”This provision shall not be applied to regions situated at an altitude of eight hundred meters or more or to the southern part of the national territory. An order of the minister responsible for town planning will specify the conditions required (JORA No. 26, 1991, p. 793).

1.3. Soil Occupation Plan (SOP):

According to the Law N° 90-29 of 01/12/1990 relative to the development and the urbanism and the complementary decree N° 91-178 of 28/05/1991, the Soil Occupation Plan (SOP) is stated as an instrument of urbanism, to be covered by each municipality, and intended to define in detail the rights of land use and construction in accordance with the provisions MPU (M.L.P., 1998).

The process of elaborating a SOP is composed of three successive phases ranging from an analysis of the current situation encompassing the area of territorial influence recalling the guidelines of the MPU of the commune of belonging, until the development of an urban and development composition accompanied by a urban and technical regulation reconciling the recommendations for three variants of this composition and the draft by-law presented during the second phase of this process. It is at the second and third phases of the SOP that environmental and energy regulations could be integrated. They can be expressed simultaneously through urban composition and at the level of regulation.

2. Examining the instrumental toolbox related to environmental protection territory planning:

The instrumental toolbox related to Environmental protection was established by an important legal text promulgated in 2003 (MEDD, 2003) which led to the creation of a National Plan for Environmental Action and Sustainable Development (NPEASS) for a five years period, managed by the High Committee on Environment and Sustainable Development.

The first NPEASS has already been established for the period 2001-2004. And it is only in 2015, twelve years later, that a law followed by its executive decree explicit to this instrument (documents, contents, methods of elaboration) be promulgated (MEDD, 2015).

On the other hand, the Law on Planning and Sustainable Development of the Territory which was published in 2001. It was intended to take an interest in the protection of the environment.

It had instituted specific toolbox of instruments aimed at spatial planning, ranging from the national scale (National Scheme: NS) to the regional scale (Regional Scheme of the Land Use Planning: RS) through the intermediate ladders (National Action Scheme to Combat Desertification: NSCD and Development and Management Scheme for the Coast: DMSC). Then the metropolitan level represented by the (Directing Scheme for Metropolitan Areas: DSMA) concerns only four Algerian cities: Algiers, Oran, Annaba and Constantine. For the wilayale scale, the Wilaya Development Plan (WAP) established in 1990 by the law on wilaya, has remained opposable only to the administrations, in the absence of any clarification or directive relating to its inclusion in all the new land use planning instruments established, either by law (General Secretariat Government , 2001).

The coastline and its very high concentration of population and activities in relation to the rest of the country have benefited from an urgent interest (E.U, 2010).

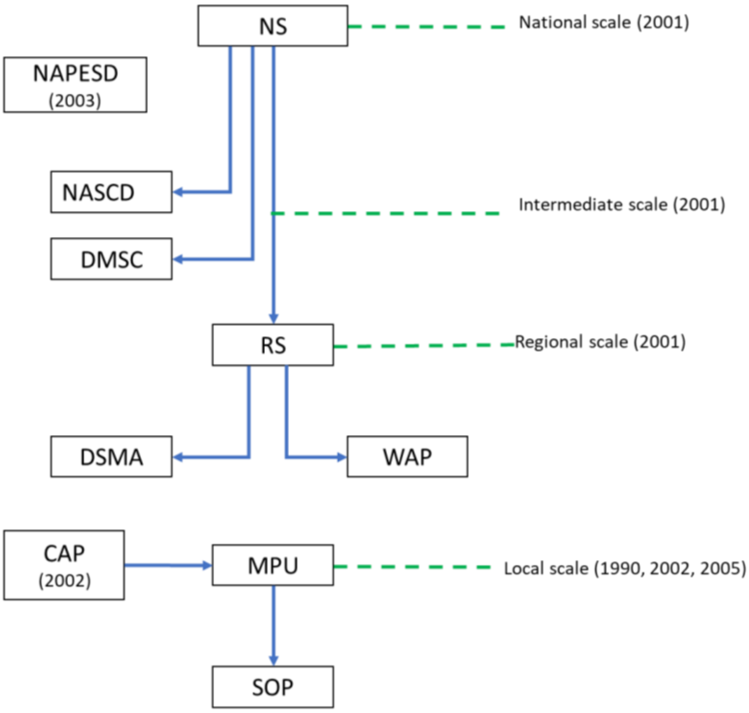


Figure 4:the different instrument related to environment protection and territory planning

- NPEASS constitutes an encouraging action undertaken by the State, however, its integration with the NS, has not been clearly mentioned, which constitutes the first level of problem in the instrumental hierarchy.
- The instruments do not neither specify the types, the content conditions and the relations that must take place between them to ensure their application.
- For cities allowed of a DCMA a persistent confusion exist with the MPU.
- The WP create a problem of confusion of intervention in the same territory if the MPU is inter-communal.
- The CAP reserves the main mission to protect coastal and sensitive areas as the law of 2002 recommends (Gherbi M, 2018), however, its relations with the DMSC (national level) or with the MPU and SOP.

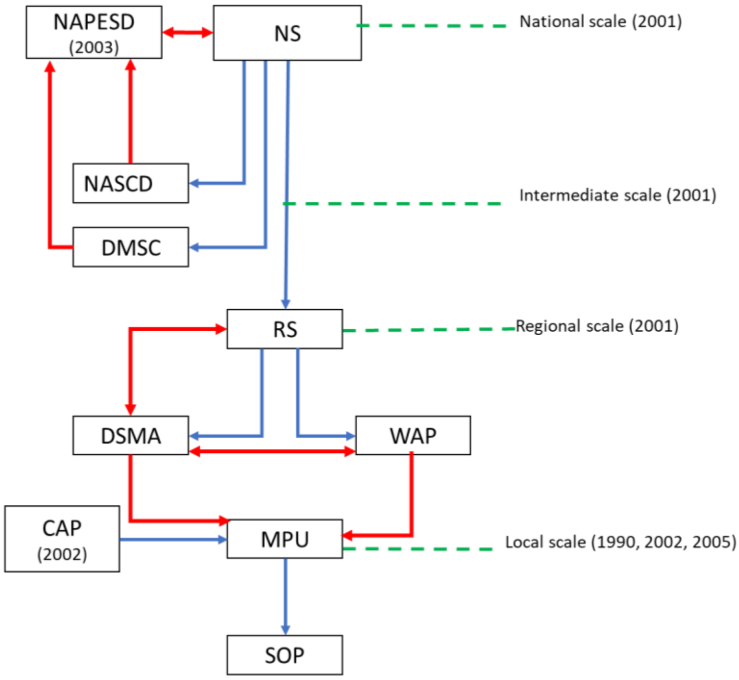


Figure 5:The missing relationships between the different instrument before the NS.

It is obvious that directives on environmental protection and territory development issued at national level cannot be transmitted explicitly to lower scale instruments, particularly those at the local scale (Gherbi M, 2018).

This is partly explained by the absence of relationships that must be established between the hierarchical instruments mentioned.

It explains, among other things, the disconnect observed between what was foreseen in the planning and what was actually achieved on the ground. This reflects, on the other hand, the lack of specific instruments for the lower levels (Gherbi M, 2018).

The urbanization has damaged their immediate and remote environments, which have resulted in the various forms of pollution (Ministère de l'Equipement et de l'Aménagement du territoire , 1998)and the excessive consumption of raw materials such as energy, in the non-renewable case (E.U, 2010).

NS provided some answers to the ambiguities surrounding the questions mentioned above, in so far as it supported the following instruments: the DMSC, the SDPTTD and the Master Plans for Development of the 4 major cities: Algiers, Oran, Constantine and Annaba.

The relationship between national level instruments do not yet exist, but they had to appear in order to insure coherence of the major actions as mentioned in the green arrow.

The same applies to the unspecified relations between DSMA and WAP or between WAP and MPU as between DMEC and CAP .

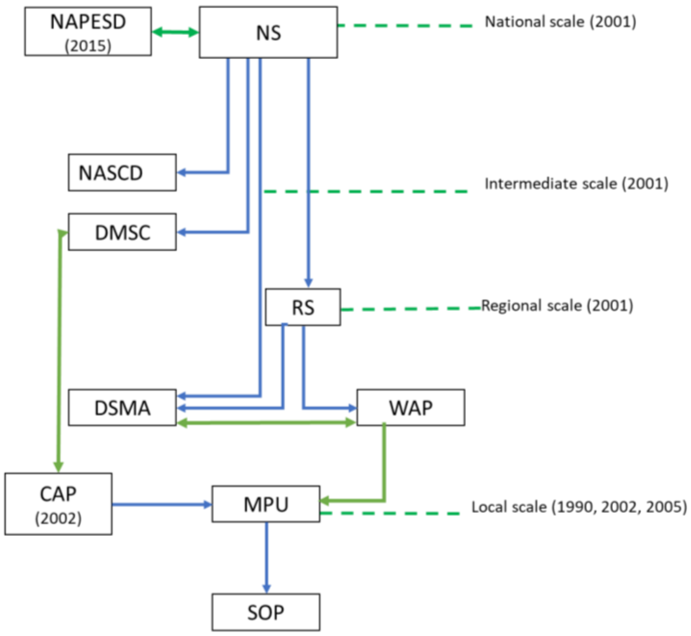


Figure 6; The organisation and the relationships between the planning instrument after NS

Weaknesses in planning instruments regarding environmental impact studies

Neither the MPU nor the SOP did not have the competence and responsibility to integrate the environmental problems (Gherbi M, 2018) threaten Algerian cities.

In this context, equipment built by private investors that must be submit an Environmental Impact Assessment studies. However, in practice, the study is reduced to a simple formality of granting authorization from the Directorate for the Environment, in order to get their building permit.

The lack of a formal model of EIA studies is one of major reasons of this abuse. This likely prompted the Ministry of the Environment to urge in its press release presented in 2012 -almost a decade after the introduction of the law (MEDD, 2003)which introduced impact studies , develop environmental impact assessment guides. The lack of expertise is another reason of failure of EIA studies.

The catch-up of MPU and SOP in the management of environmental problems was clearly legible with the promulgation of important texts in 2004 and 2005 to give them more strength and credibility.

These texts have, for the first time, required the association of new actors represented by the decentralized representatives of the State at local level, namely the departments responsible for the environment, Tourism and spatial planning (long absent) in the development of the MPU and SOP.

The latter, and according to these texts, are supposed to take care of the particular concerns on the coastline of the authorized economic activities that are enacted by the CAP provided for by the law of 2002.

Since its inception, the environment as a department that has been attached to different ministries. Added to this instability, the segmentation identified between the environmental and spatial vision from national to local levels.

Both reasons generate a complexity in the projection of the environmental vision on the territory planning and the practice of their strategies in reality.

Section conclusion:

The shortcomings covered on the analysis did not allow the proper transmission of top-down directives.

These shortcomings can also to be useful to make proposals on a bottom up approach.

Added to the conflict of scale from national to local instruments, the highlighted stigmatization between environmental dimension and local planning instrument MPU and SOP is another barrier of the effectiveness of the planning instrument in practicing the environmental directives on city scale.

This situation reflects an interruption between the local level and the higher levels which normally serve as a frame of reference, guidance and support for the coherent and judicious development of its instruments.

3. Investigating the existing regulatory framework of renewable energy in architecture and urban planning process:

In the following part of work, we will hold an investigation on the major laws of reference in the building, planning and renewable energy sector. The analysis will be divided on two part the first one will treat the building sector while the second one will treat renewable energy and energy efficiency preoccupations.

An obvious and hidden content analysis will be applied. The themes to be noted in these texts are those that refer to environment interfering with the built environment in this case all that is related to the sun, light, wind, air, noise, lighting, thermal comfort, energy.

These themes can be manifested very explicitly, openly declared and specify precise urban and / or architectural dimensions, or are expressed in a latent and implicit way, remaining on a very global scale of political will which requires reading between lines (Table 1).

Regulations	Articles with obvious content	Articles with latent content
Law No. 90-29 of 01/12/1990 on planning and development (JORA No. 52, 1990)	None	4 , 47
Executive Decree No. 91-175 of 28/05/1991 laying down general rules for development, town planning and construction (JORA No. 26, 1991)	21, 22, 24, 35, 36, 37, 38, 39, 42 45	2, 4, 5, 23, 26, 30, 41
Law No. 99-09 of 28/07/1999 on energy control (JORA No. 51, 1999)	3, 6, 10, 11, 12, 18, 20	4, 5
Law No. 04-09 of 14/08/2004 on the promotion of renewable energies in the framework of sustainable development (JORA No. 52, 2004)	3, 5	2, 10
Executive Decree No. 2000-90 of 24/04/2000 on thermal regulation in new buildings.	All	None

Table 1:Analysis of Algerian regulations concerning built environment and energy "source: the author"

Regulations related to the built environment:

Law No. 90-29 of 01/12/1990 reveals the latent statements relating to environmental aspects interfering with the built framework. Article 4, for example, expresses attention to the protection of ecological balances when proceeding the act of building. Article 47, draws attention to the specificities of natural and cultural territories, but without giving any applicable guidelines at the urban or architectural scale.

A second analysis was carried out on the text of Executive Decree No. 91-175 of 28 May 1991 defining the general rules for planning and construction. This analysis resulted in the identification of ten (10) articles that present rules relating to environmental aspects as stated in section 21*: "At least half of the elevations, which are used to illuminate the living rooms, must have at least two hours of sunshine per day for at least two hundred days per year. Each dwelling must be arranged in such a way that at least half of its habitable parts are dated on the facades meeting these conditions."*(JORA 26, 1991, p.791).

The analysis also identified seven other articles indicating it latently, such as this extract from Decree No. 23 when a building is to be built along a public road, its height shall not exceed the distance counted horizontally between any point of it and the point closest to the opposite alignment' (JORA No. 26, 1991, p.791).

It should be noted that all sections of this decree are restricted to residential buildings. While the others deal much more with general aspects such as hygiene and sanitation, environmental nuisances, with indications relating to urban (density and prospect) dimensions and architectural (natural ventilation) dimensions. Those with demonstrable content specify data relating to the ventilation and natural lighting. It is also easy to see that it is often stated that certain standards do not concern southern Algerian Sahara areas and that additional regulations will remedy these shortcomings as set out in Articles 25 and 35.

Regulations related to energy:

The legislation reviewed demonstrate a clarity in the regulatory statement. The statements on rationalization of energy consumption and energy efficiency, thermal insulation and bioclimatic architecture are the most concrete aspects to implement that are cited in these laws. The thermal regulation of new buildings is advanced by an executive decree in order to implement these laws.

Through these texts, it is obvious that the thermal aspect alone constitutes a focal point of all the articles of the Algerian regulation in terms of energy control. It goes without saying that this aspect is only one element among others and that will unfortunately not be enough for itself. Added to that, the fact that this aspect has been restricted to its architectural dimension without arising the urban dimension which should not be neglected.

Section conclusion:

The texts relating to energy refer to methods of calculation that the architect can apply only after his design, therefore, once his formal decisions and choices are made. These standards should inspire it in the early stages of its design and allow it to rejuvenate continuously. Also, these texts should cover all energy and environmental aspects, because the architectural project cannot lend itself to a one-way vision but must be a synergy of multiple constraints.

It is worthy to congratulate the efforts made so far in the Algerian regulatory context. However, It is necessary to think about inserting, within the regulations, instruments of urbanism and texts complementary in the current regulations in order to fill the gaps noted.

4. The architectural integration Quality of solar active technologies:

Solar energy, in its active or passive forms, is able to deliver the entire set of building energy needs (MC Munari Probst, C Roecker, 2012).

- Domestic hot water (DHW) can be produced using active solar thermal collectors;
- Heating can be easily provided by the direct (passive) solar gains heating the building through the windows (greenhouse effect). As it can also be provided indirectly, by using active solar thermal collectors;

- Electricity for appliances can be produced by photovoltaic modules;
- Space lighting should be provided as far as possible by using passive sun light (day lighting, photovoltaic modules can then provide what is needed for electric lighting;
- Space cooling can be greatly supported by appropriate passive night ventilation. Recently solar thermal systems able to transform solar heat into cold have been developed help in deliver building cooling needs. These systems use standard solar collectors, but are for the moment mostly available as experimental systems.

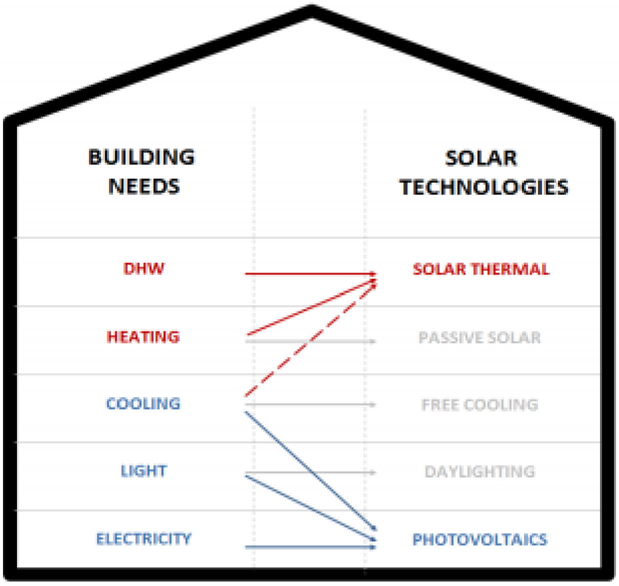


Figure 7: Different solar technologies covering different building energy needs (MC Munari Probst, C Roecker, 2012).

Solar active technologies integration problematic at building scale :

The passive use of solar gain in the buildings has always been a crucial part of the architectural design process. Since the passive use does not bring new elements to the building it does not pose integration issues so it will not be treated in this work. Meanwhile the accelerated trend of use of active technologies solar thermal collectors and photovoltaic modules in buildings needs a careful consideration by architecture to meet the building energy needs without compromising the architectural quality.

Architectural integration quality is defined as the result of a controlled and coherent integration of the solar collectors simultaneously from all points of view, functional, constructive, and formal (aesthetic)(Marcus Vitruvius Pollio, 30-20 bC)
I.e. when the solar system is integrated in the building envelope (as roof covering, façade cladding, sun shading, balcony fence…), it must properly take over the functions and associated constraints of the envelope elements it is replacing (constructive/functio nal quality), while preserving the global design quality of the building (formal quality). If the design quality is not preserved (i.e. the system is only constructively/functionally inte grated into the building skin without a formal control), we can only call it a building inte grated system (T. Herzog , 1999) (R. Krippner , 2003) (A. G. Hestnes, 2000) (A.G. Hestnes, 1998)

(I.B. Hagemann , 2002) (T. Reijenga, 2000) (MC Munari Probst, C Roecker,, 2011).

4.2. Functional and constructive integration aspects :

The building envelope has to fulfill a wide and complex set of protection and regulation functions (MC Munari Probst, C Roecker, 2012), with an obligation of the use of different components (opaque/ transparent elements, monolithic/ multilayer structures, fixed part) (MC Munari Probst, C Roecker, 2012). In order to meet the standard functions and durability of the whole, The integration of solar modules in such complex envelope should be studied carefully (MC Munari Probst, C Roecker, 2012).

The multifunctional use of solar elements taking over one or more envelope functions may ne ed an extra effort (MC Munari Probst, C Roecker, 2012), calling for instance for some modifications in the original design of the collector, in the way it is mounted or by restraining its use in some parts of the building (MC Munari Probst, C Roecker, 2012). By the oder hand, it reduces the global coast and improves the architectural quality of the integration (MC Munari Probst, C Roecker, 2012).

In addition to the functional compatibility, it is important to ensure that the new multifunctional envelope system meets all building construction standards (MC Munari Probst, C Roecker, 2012):

- The collector load should be correctly transferred to the load bearing structure throug h appropriate fixing;
- The collector should withstand fire and weather wear and tear;
- It should resist wind load and impact, and should be safe in case of damage;
- Risks of theft and/or damage related to vandalism should be evaluated and appropriat e measures taken;
- The fixing should avoid thermal bridges and the global U value of the wall should not be negatively affected;
- Vapour transfer through the wall should avoid condensation layers, and allow the wall to dry correctly.

Besides the construction standars cited above , the integration of solar systems implies other issues resulting from specific technology attributes: i.e. the presence of a hydraulic system(STà or electric cabling (for PV) and the high temprature of some modules (MC Munari Probst, C Roecker, 2012).

- The hydraulic system of ST should be carefully studied to deal with water pressure diff erences aat the different façade levels (heights), should be safely positioned within the envelope structure and should remain accessible; measures to avoid damages res ulting from water leakage should also be taken;
- The electric cabling of PV should be studied to avoid shock hazards and short circuits, and measures should be taken to avoid fire.
- Envelope materials in contact with the solar modules should withstand their high worki ng temperature;
- Fixing details and jointing should make collector's materials expansions compatible with those of the other envelope materials;
- Safety issues should be considered for collectors within users' reach to avoid burning o r shock hazards (ground floor, window and balcony surrounding...).

The integration of a "solar collection" into the building envelope is not as simple as it seems. It requires an understanding of where (opaque parts, transparent parts, fixed/mobile elements), h ow,and which collectors can be made compatible with the other envelope elements, materials,and fu nction (MC Munari Probst, C Roecker, 2012).

4.3. Formal integrationaspects (aesthetics):

All the system characteristics affecting building appearance shoud be coherent with the overall building (MC Munari Probst, C Roecker, 2012):

- The position and dimension of collector fields have to be coherent with the architectural composition of the whole building (not just within the related façade)
- Collector visible material, surface, texture and colour should be compatible with the other building skin materials, colours and textures they are interacting with.
- Module size and shape have to be compatible with the building composition grid and with the various dimensions of the other façade elements.
- Jointing types must be carefully considered while choosing the product, as different join ting types underline differently the modular grid of the system in relation to the buildi ng.

Mastering all characteristics of an integrated solar thermal system in both perspectives of ener gy production and building design is not an easy task for the architect (MC Munari Probst, C Roecker,
2012). The formal characteristics of the system are strongly dependent on the specific solar te chnology, which imposes the core components of the solar modules, with their specific shapes and materials. The more flexibility that can be offered within these imposed forms and materials, the more chances for a successful integration (MC Munari Probst, C Roecker,, 2011). (MC.Munari Probst, C.Roecker,, 2007).

5. The architectural integration of solar Photovoltaic PV technologies :

Photovoltaics (PV) is a way of generating electrical power by converting solar radiation into electricity. Materials discussed thoroughly in the following sections, include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenide/sulphide.

5.2. Available PV technologies:

- **Wafer based crystalline silicon cells:** Monocrystalline cells (scSi), Multicrystalline cells (mcSi) Solar cells madefrom crystalline silicon continue to account for about 85% of the cells used worldwide. Crystalline silicon cells (CSi) are subdivided in two main categories:
  - ✓ single crystalline (sc-Si):
    Monocrystalline cells are produced from silicon wafers; these wafers are extracted from a square block of single crystal silicon, by cutting slices of approximately 0.2 mm thick. This produces square cells of 100 to 150 mm sides with a homogeneous structure and a dark blue / blackish colour appearance.
  - ✓ multi-crystalline (mc Si) :
    the melted silicon is cast into square ingots where it solidifies into a multitude of crystals with different orientations (frostlike structure), which gives the cells their spotted and shiny surface.

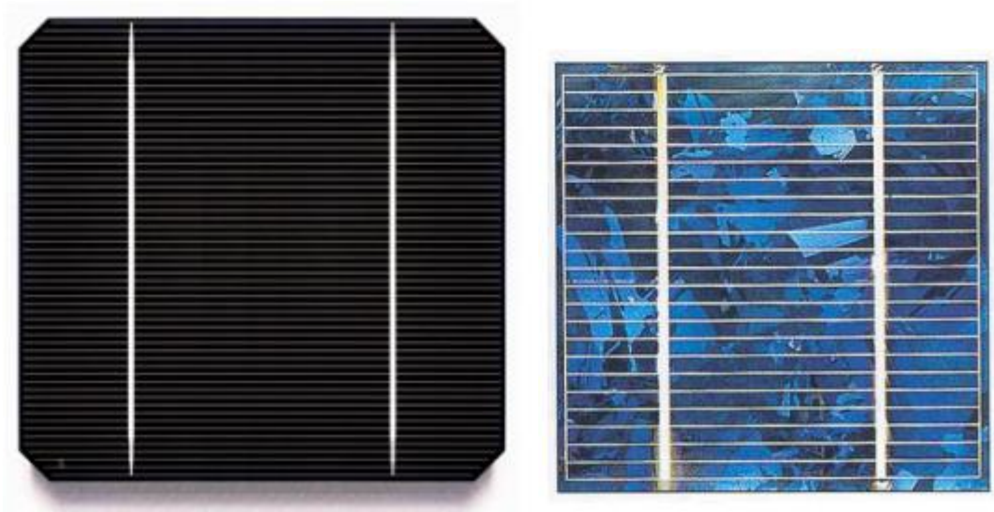


Figure 8: mono and poly crystalline cells

The efficiency of monocrystalline cells is currently the highest available on the market, ranging approximately from 17% to 22%, while multicrystalline cells are around 11% to 17%.

- **Thin-film cells** (also called "second generation" solar cells) and their contact are deposited directly on large area substrates, such as glass panels, stainless steel or polymers (square met re-sized and bigger) or foils (several hundred meters long). Thin films can be seen as a microscopical ly thin layer of "disordered" photovoltaic material that gives the module surface a more homoge neous appearance. With respect to wafer based crystalline technology, thin-film PV has a low coast potential because its manufacture requires only a small amount of materials.

Thinfilm solar cells are usually categorized according to the photovoltaic material used, the three mai n technologies being amorphous silicon (aSi), Copper Indium Gallium Selenide (CIS or CIGS) a nd Cadmium Telluride (CdTe). The most common material is amorphous silicon. The productio n of amorphous or micromorphous silicon has undergone the most development (and this is why it is more diffuse than the other two thin film technologies) while the cadmimtelluride promises t he lowest production costs and copperindiumgallium diselenide achieves the highest conversion efficiencies (the new record value for flexible CIGS solar cells was reached in May 2011, by t he EMPA laboratory, about 18.7% and nearly closes the "efficiency gap" to solar cells based on polycrystalline silicon wafers or CIGS thin film cells on glass).

Figure 9:amophous and silicon cells and modules

While for standard amorphous silicon cells the efficiency lies among 4% to 8%, some manufactu rers produce modules with combined cells (multijunctions), reaching efficiencies around 10%. CIGS ce lls can reach 12%.

Emerging and novel PV technologies (third generation) :The category “Emerging” is used for thos e technologies which have passed the “proof-of concept” phase, or could be considered as mid-term options compared with the two main established solar cell technologies (crystalline Si an d thin-film solar cells). The category “Novel” will be used for developments and ideas which can le ad to potentially disruptive technologies, but where there is not yet clarity on practically achievable conversion efficiencies or structure cost. Sometimes they are called also ”third generati on” Among the emerging PV technologies, organic solar cells play an important role. In fact, o rganic

solar cells have already been subject of R&D for a long time, because they offer the prospect of very low cost active layer material, low-cost substrates, low energy input and easy up scaling cells.

New polymer cells are also appearing in the market. The main advantage of these cells is a m uchlower cost than crystalline or thin film ones, but due to their low efficiency and durability (up tonow) they are not yet considered competitive in the market. Their efficiencies range fro m 4% upto 10%.

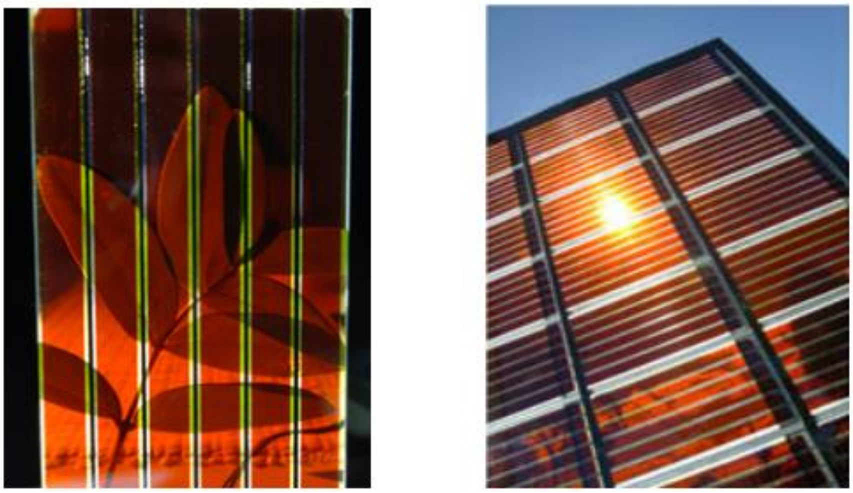


Figure 10:dye-sensitized solar cell and module

5.3. PV system

Stand alone systems are autonomous installation that supply one or more loads independentl y of any electricity grid, for example, systems for isolated houses, mountain huts or isolate far ms, far from urban settlements, without access to the public grid. For this reason, the solar e nergy produced by the PV plant must balance the energy required. In most cases, rechar geable batteries are used to store the energy surplus and are coupled with dieselpower gener ator or other additional energy generator (wind turbine for example). Stand alone system ar e also very common in thinly populated or poor regions of the world. Such installations can ra ise the living standard of the population.

Gridconnected systems In order to avoid costly storage systems (like batteries) and to reduce the high losses, PV installations are connected to the electricity grid, when possible and use it as virt ual storage. The PV modules produce direct current (DC) electricity, whereas the electricity supply (th e grid) is alternating current (AC). An electrical device called inverter is used to convert the D C to AC. The inverter is installed with switches on each side to allow it to be isolated for maintenanc e. The AC output from the solar installation is wired back to the main consumer unit in the building, where it should have a dedicated circuit breaker. A further switch gives the user a point of e mergency isolation, and an energy meter is normally added to enable the visualization and co ntrol of the performance. The consumer unit is connected to the electricity grid via an expo rt meter.

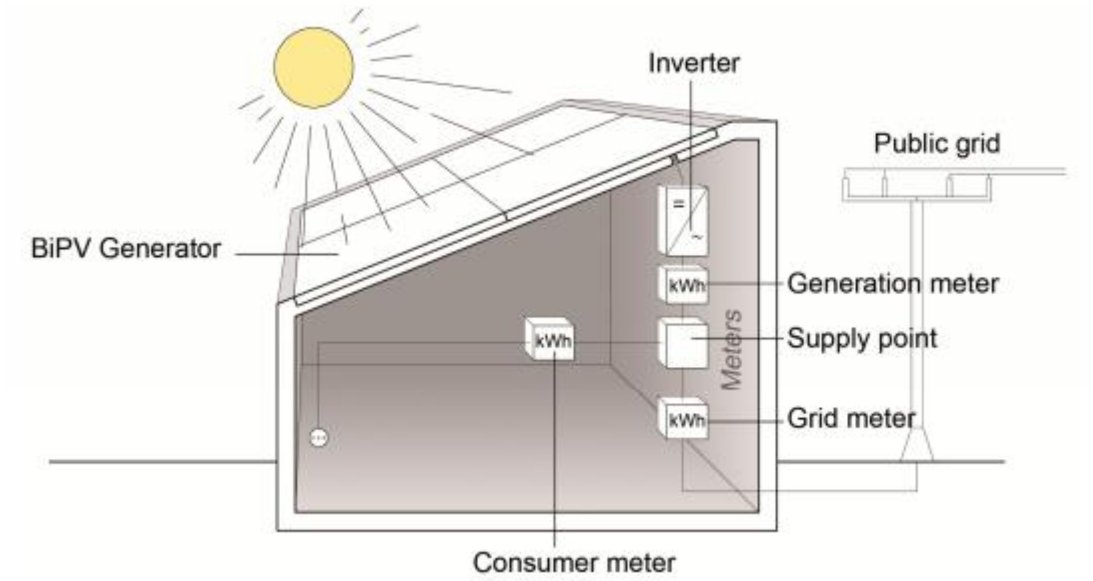


Figure 11:Scheme of a common grid-connected roof integrated PV installation

5.4. Photovoltaics and the building envelope

5.4.1. Photovoltaics and the conceptual integration into the envelope

Since Photovoltaics offer architects many design possibilities, like a common building material no categorization is exhaustive enough for describing all the ways to integrate Photovoltaics into the building concept. In order to simplify how Photovoltaics can be used in the envelope composition, six main categories have been defined:

1. added technical element
2. added elements with double function
3. free standing structure
4. part of surface composition
5. complete façade/roof surface
6. form optimized for solar energy
7. other (if not in 1-6. category)

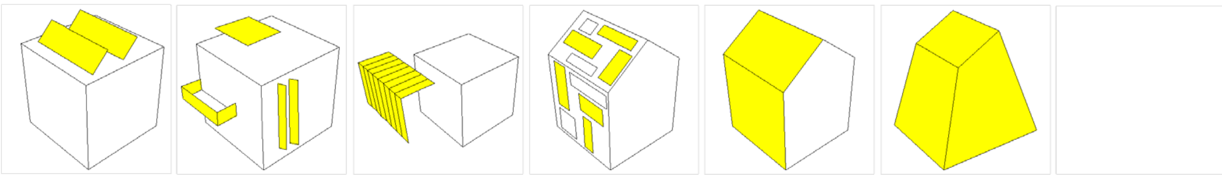


Figure 12:Conceptual integration typologies 1-7. (from left to right) used in IEA Task 41 – Subtask C

5.4.2. Photovoltaics and the technological integration into the envelope

Photovoltaic modules can either be applied on top of the building skin (BAPV-Building Added Photovoltaics), or integrated into the envelope constructive system (BIPV-Building Integrated Photovoltaics).

In the first case photovoltaic modules are most commonly considered just as technical devices added to the building, even though there are constructively added systems that are integrated parts of the architectural concept. However, considering Photovoltaics as building components that are integral parts both of the constructive system and the overall architectural design leads usually to good architectural solutions, as several innovative projects demonstrate.

If we look at the two basic ways of using Photovoltaics in buildings (added on or BIPV), we can distinguish two main categories of PV products that can be used by architects. The first category, for BAPV require additional mounting systems; while the second one, for BIPV, with specially developed PV products, has the potential to meet all the building envelope requirements (such as mechanical resistance, thermal insulation, etc….). A variety of special PV components have been

developed lately and is available on the market to match building integration needs [3-B.6].

Across these two perspectives, it is also possible to set up a topological-technological approach. The framework of this categorization is provided by the placement of the PV system in the building envelope (i. e. roof, façade, etc….), and then the way it is technologically integrated into the envelope system (BAPV or BIPV). The next paragraphs discuss the possibilities of using PV in the different parts of the building envelope, according to the topological-technological approach mentioned above.

5.4.3. Photovoltaics and the building envelope

Three main categories are used: roofs, facades, and external devices. These categories will inclu de different technological ways of using PV in the envelope, that lead to different choices of the PVcomponent.

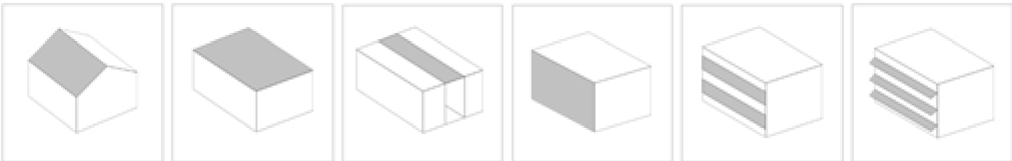


Figure 13:Integration typologies into the building envelope used in IEA Task 41 – Subtask A . From left to right: Tilted roof; Flat roof; Skylight; Facade cladding; Facade glazing; External device.

a. *Roofs:*

A PV component can be added on the roof, can substitute the external layer of the roof sys tem (i.e. PV as a cladding), or it can also substitute the whole technological sandwich (i.e.sem itransparent glass modules as skylights). Depending on the layer(s) the PV component substitut es, it has to meet different requirements that influence the choice of the most suitable PV com ponent.

Opaque – Tilted roof

Building added PV systems have been very common on tilted roofs, especially in case of integration into existing buildings. Using this solution, there is a need for an additional mount ing system and in most cases the reinforcement of the roof structure due to the additional loads.

Figure 14:crystalline roof systems: Solar tile © Ideassolar, Solar slate © Megaslate, Solar slate © Sunstyle Solaire

Figure 15: thin film roof systems. From left to right: Solar tile © SRS Sole Power Tile, Solar shingle © Unisolar, solar laminate on metal roof © Rheinzink

The system mentioned above have been highly criticized for its aesthetics that urged the market to provide building integrated products replacing all types of traditional roof claddings. There are products both with crystalline and thin film technologies for roof tiles, shingles and slates that formally match with common roof products. Several metal roof system manufacturers (standing seam, click-roll-cap, corrugated sheets) developed their own PV products with the integration of thin film solar laminates. Moreover, there are also prefabricated roofing systems (insulated panels) with integrated thin film laminates available. Depending on the insulating features, these PV "sandwiches" can be suitable for any kind of building (i. e. industrial or residential). It is somewhat surprising that many so called "first generation" BIPV products (i. e. roof tiles) proved to be unsustainable due to many reasons (especially cost-effectivenes.

<u>Opaque – Flat roof</u>

In the case of flat opaque roofs, we can distinguish among PV systems with different tilt angles and PV systems on the same plane of the roof. The most common are added systems with rack supporting standard glass-Tedlar modules or to use specific tilted rack system for thin film laminates

Figure 16:crystalline modules for flat roof. Left: standard module on rack mounting system, © Prosolar

There is also a possibility to use crystalline modules with plastic substrates allowing a seamless integration on the roof with an adhesive backing. Thin film technologies also offer different flexible laminates, with plastic or stainless steel substrates, that can be easily mounted on flat roofs.A recent trend for flat roof is using the waterproof membrane as a support on which flexible amorphous laminates are glued, providing a simple and economic integration possibility.

Figure 17:integration of thin film laminates on flexible substrate in flat roof.

Semi-transparent – translucent roofs

The PV system can also become the complete roof covering, fulfilling all its functions. Most commonly semi-transparent crystalline or translucent thin film panels are used in skylights. These solutions provide controlled day lighting for the interior, while simultaneously generating electricity. In the selection of the product it is important to consider the thermal (such as U-value and g-value) and day lighting features. Semi-transparent crystalline modules are sometimes custom-made. In this case it could happen that the architect has no technical information and data about the performance of the component from the manufacturer. A simulation or a special test or measurement should then be asked for. Standard translucent thin film modules, however, have more detailed datasheets with this information.

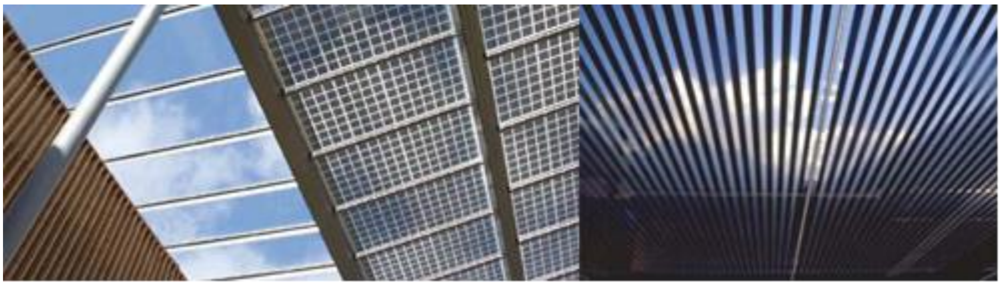


Figure 18: semi-transparent skylights. Left: Community Center Ludesch, Austria, Herman Kaufmann: semi- transparent modules with crystalline cells © Kaufmann. Right: Würth Holding GmbH HQ: semi-transparent thin film modules © Würth Solar.

Transparent modules can also be used for open and indoor atria. In both cases the glazing should meet the standards for mechanical resistance, while in the latter also the thermal requirements (U-value and g-value) of the envelope.

Figure 19:semi-transparent skylights. Ospedale Meyer, Florence. CSPA Firenze, Paolo Felli, Lucia Ceccherini

b. Facades

A PV component can substitute the external layer of the facade (i.e. PV as a cladding of a cold facade), or it can substitute the whole façade system (i.e. curtain walls – opaque or translucent. Depending on the layer(s) the PV component substitutes, it has to meet differentrequirements that influence the choice of the most suitable PV component. In the following, a general overview of the way PV can be used in facades is presented.

Opaque - cold facade

Photovoltaic modules can be used in all types of façade structures. In opaque cold facades, the PV panel is used as a cladding element, mounted on an insulated load-bearing wall. In this case, the PV is usually back ventilated, to avoid lowering the efficiency of the cells . As the cooling air is heated by the panels, some systems make use of it for building heating (PVT). Several fastening systems have been developed for façade cladding, both with framed panels and laminates (unframed modules) and for all PV technologies.

Figure 20:A Facade cladding solutions. Left: Soltecture Solartechnik GmbH, Berlin, Germany, © Soltecturel. Right: Paul-Horn Arena, Tübingen, Germany, Alman-Sattler-Wappner, © Sunways.

Opaque – non-insulated glazing and warm facade

Curtain wall systems with single glazing (for non insulated facades) or double glazing modules with adequate U-values (fig.24) also offer opportunities for PV integration. These can be either opaque or semi-transparent/translucent.

Figure 21:warm façade solution. Zara Fashion Store, Cologne, Germany, Architekturbüro Angela und Georg Feinhals: opaque monocrystalline cells combined with transparent glazing in post-beam curtain wall structure, © Solon.

Semi-transparent and translucent façade parts
PV modules for application in semi-transparent/translucent parts of the façade are glazed modules with either crystalline cells covering only a part of the glass area (cells spacing), or amorphous panels with very thin layer and/or larger stripes free of PV.

Figure 22:Schott Headquarter Mainz, translucent thin film module, © Schott.

Most commonly solar cells are integrated into curtain wall systems to create translucent modules. The different curtain wall structures (post-beam structure, structural sealant glazing and spider glazing systems…) give various possibilities of framing and architectural appearance.

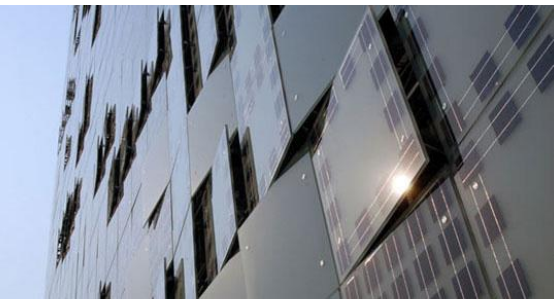


Figure 23:GreenPix Media Wall, Beijing, China, Simone Giostra & Partners: frameless modules with spider

When working with a semi-transparent PV in façades, an important consideration is its direct impact on the indoor climate. The solar modules act only as a partial sun protection, and they can also heat the air inside the building. Visual discturbance and daylighting issues have to be considered also. Special PV elements offering a good thermal insulation (low U-value) are available to be used in combination with standard double or triple glazing elements. The outer layer of a double-skin façade is also a possible option for PV integration.

c. External devices

PV as sun protection

Photovoltaic modules can be used as shading devices. Quite common these are semi-transparent glass-glass components integrated as canopies or louvers, but there are also movable shutters with semi-transparent crystalline or thin film.

Figure 24:solar shading solution: Left: Colt Ellisse PV sliding shades at Company HQ, Bitterfeld-Wolfen, Germany, © Colt, Right: Keuringsdienst, Eindhoven, The Netherlands, Yanovshtchinsky Architekten: using Colt Shadovoltaic as shading device, © Colt.

Opaque sun protections are also well used, in most cases with an upper part without cells, to avoid shading the PV cells when the shades overlap.

Figure 25:SBL Offices Linz, Austria, Helmut Schimek, shading louvres with integrated photovoltaics and suntracking system, © Colt

Spandrels, balconies parapets

Spandrels and parapet areas are also suitable for photovoltaic integration, mostly using glass- glass semi-transparent modules made of security glass (SSG). Balcony fronts can either be two- paned solutions to protect the PV-cells or single glasses to which the PV-cell is laminated. In glazed verandas, the heat generated at the back of the PV can be used to create thermal comfort in spring and autumn, while the space can be opened for natural ventilation in summer time.

Figure 26;spandrels and parapet solutions. Left: Housing Estate, Ekovikki, Finland, Oy Reijo Jallinoja: semi- transparent PV modules with two-paned glazing in parapet areas, Resource: PV NORD. Right: Kollektivhuset, Copenhagen, Denmark, Domus Arkitekter: PV cells

5.4.4. Innovative envelope and external devices systems (curtains, leaves)

Polymer technologies offer innovative products for special added function like solar curtains for the interior or solar leaves that can replace the ivy running on the wall. These products have very low efficiency, but their initial cost is also very low. On the other hand they
are very sensitive to light and can therefore function well in diffuse light or behind a window.

Figure 27:innovative third generation PV solutions. Left: Solar Tile curtain with polymer solar cells and phase

6. The architectural integration of solar thermal ST technologies : :

6.2. Available solar thermal technologies :

Solar thermal energy can be used for different building applications: direct or indirect space heating, domestic hot water production (DHW), and also for building cooling. It can be collected in different ways, using different technologies.

- Passively, through the transparent partsof the building envelope, storing the gains in the building. These systems can only be used for space heating, and will not be further considered here as they are part of the standard knowledge of today’s architects.

- Actively on surfaces optimized for heat collection (solar absorbers) placed on the outside of the building envelope, and transported by a medium either directly to the place of use or to a storage.

Among active systems, two main families can be identified according to the medium used for the heat transport: air collectors systems and hydraulic collectors systems.

Air
systems characterized by lower costs, but also lower efficiency than hydraulic ones, mai nly due to air low thermal capacity. Solar thermal gains are generally used immediately and without storage, for pre-heating the fresh air needed for building ventilation (figs.3.A.1 - 2). The heat can also be store d by forcing the air to circulate in a stones bed underneath the ground, or by using the solar air as cold source in a heat pump air/water; such applications can be quite expensive, and are therefore rare. Like passive systems, air systems can only be used for spa ce heating.

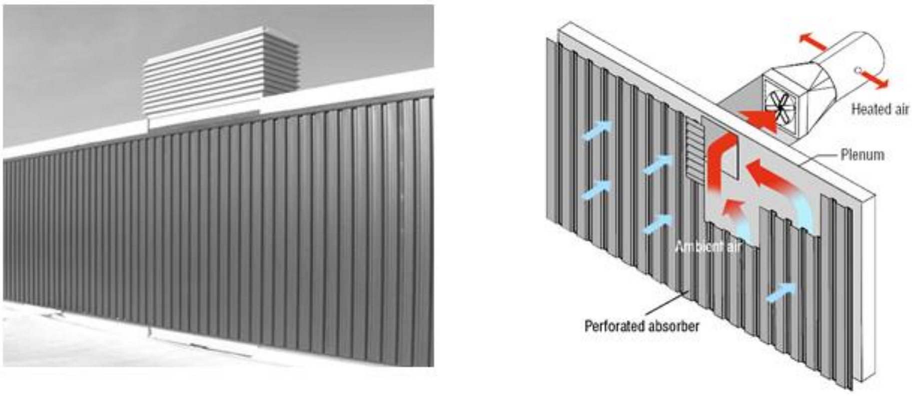


Figure 28:: Solar Wall collector system (left). Air collector system working principle (right) (US Department of energy)..

Hydraulic systems represent the bulk of solar thermal systems for buildings. As opposed to air systems, they allow an easy storage of solar gains and are suitable both for domestic hot water (DHW) production and for space heating. Being cost effective, they are crucial to help reducing building fossil fuel energy consumption (Concentrating collectors do also exist but they are not really relevant for the topic of building integration treatedhere. This is also true for unglazed plastic collectors which, due to their very low working temperatures, are only used for swimming pool or aquaculture process water heating) .Hydraulic solar thermal systems can be divided into three technologies :

- - Evacuated tubes collectors;
- - Glazed flat plate collectors;
- - Unglazed flat plate collectors;

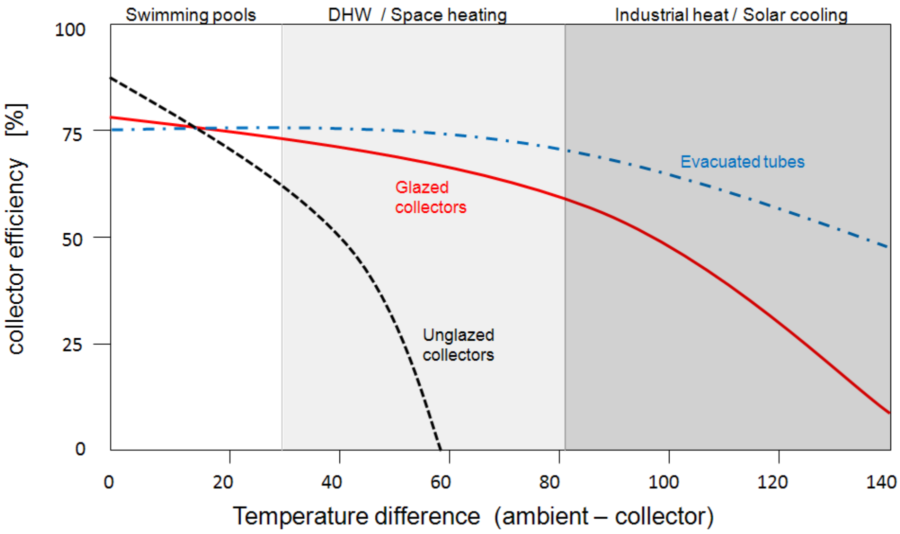


Figure 29:Comparison of the different solar thermal technologies relevant for DHW and space heating (US Department of energy).

- **Glazed flat plate collectors** (fig. 3.A.5) are the most diffused in the EU and typical applications are DHW production and space heating.They usually consist of 10 cm thick rectangular boxes of about 2 m2, containing several layers:
  - ✓ a metal plate with a selective treatment, working as solar absorber
  - ✓ a hydraulic circuit connected to the absorber
  - ✓ a back insulation
  - ✓ a covering glazing, insulating the absorber by greenhouse effect.

Usual working temperatures are between 50°C and 100°C, but they can rise up to more than150°C in summer (mid latitude climates). Therefore, measures should be taken to avoid overheating risks which can damage sensible parts (rubber jointing for instance).

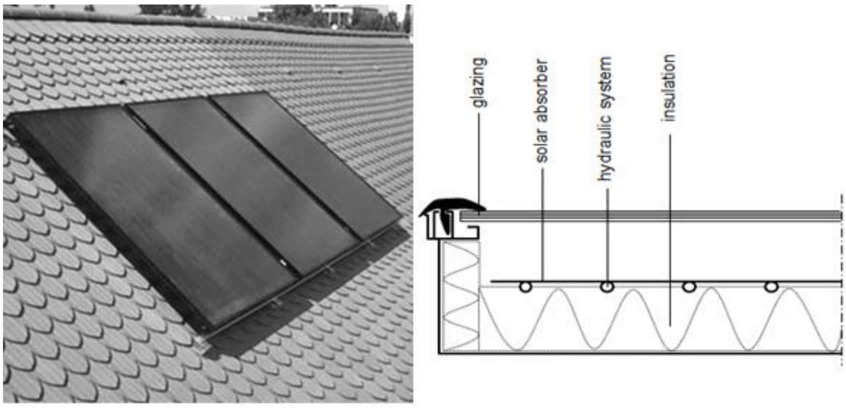


Figure 30:Glazed flat plate collectors applied on a tilted roof (left). Right: Typical glazed flat plate collector's cross section and main composition elements.

- **Unglazed flat plate collectors** are adequate for swimming pools, low temperature space heating systems and DHW pre-heating.They are composed of a selective metal plate (the absorber) and a hydraulic circuit connected to this absorber. When used for DHW or space heating they also need a back insulation, but differently from glazed collectors, the front part of the absorber is not insulated by a covering glass. Consequently, working temperatures are lower, reaching 50-65°C.When used for swimming pool water heating, the back insulation is not needed. For this specific application, polymeric absorbers can also be used to replace the more performing -and more expensive- selective metal plates (most often black polymeric pipes systems).

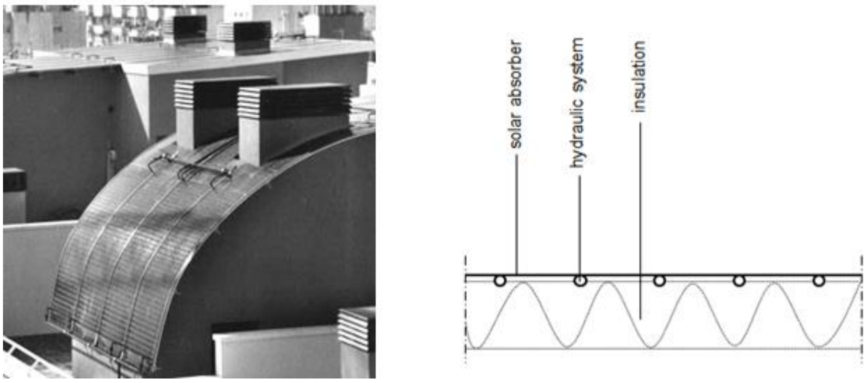


Figure 31:Unglazed flat plate collectors as roof covering (left). Right: typical unglazed flat plate collector's cross section and main composition elements.

- <u>Evacuated-tube collectors</u> Evacuated tubes are especially recommended for applications requiring high working temperatures such as industrial applications and solar cooling, but are also used for domestic hot water (DHW) production and space heating, particularly in cold climates. They are composed of several individual glass tubes, each containing an absorber tube or an absorber plate bound to a heat pipe, surrounded by a vacuum. The very high insulation power of the vacuum allows reaching very high temperatures (120-180 °C) while keeping losses to a minimum even in cold climates.

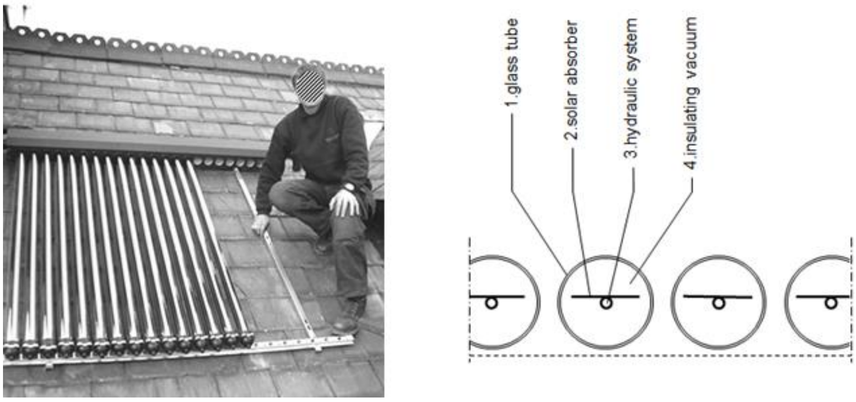


Figure 32:Vacuum tubes collectors mounted on a tilted roof (left). Right: typical vacuum tubes collector's cross section and main composition elements.

6.3. Integration possibilities in the building envelope :

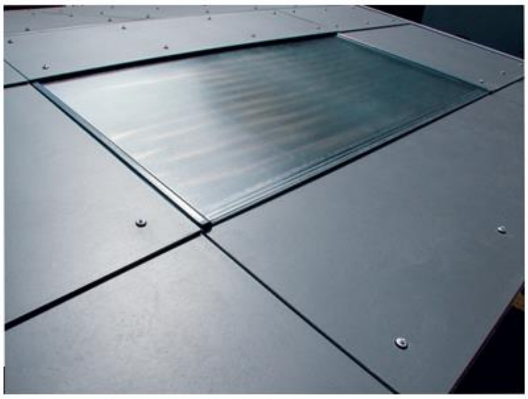
As they need solar radiation to work, solar collectors must be placed on sun-exposed areas of the building envelope. They can either be merely applied on top of the building skin, or properly integrated into the envelope constructive system.

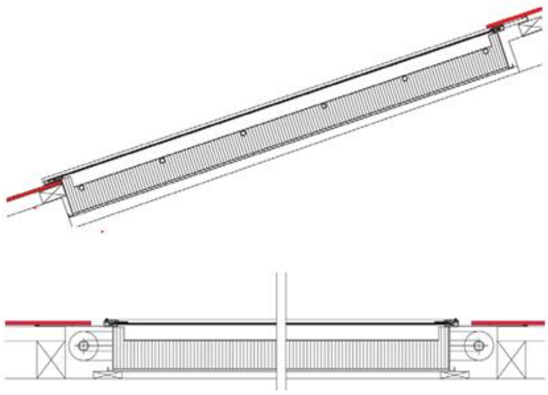
Installers often choose the technically less complex approach and treat the solar system just as an added technical element, with mitigated architectural results.

Figure 33:Integration of collectors as added elements on the roof.

For the second approach, which is in general more appealing for architects, the different characteristics of the technologies described above must be considered in order to evaluate integration possibilities in the envelope (transparent/opaque parts, mobile/fixed, multilayered/single layered ...).

The structure of flat plate collectors (glazed and unglazed) is well adapted to replace parts of roof coverings or façade cladding. The insulation behind the absorber plate and the insulation of the building envelope can be merged to become one single element, or they can complement each other. The water tightness and insulation can be directly overtaken by the absorber plate for unglazed collectors, or by the front glazing for glazed ones.





(Eternit / Soltop, s.d.).

Figure 34:: Integration of a glazed flat plate collector as part of the multilayer roofing system, picture and details

Figure 35:Façade integration of glazed flat plate collectors as façade cladding, detail and picture. (AKS Doma, s.d.)

Figure 37Roof integration of unglazed flat plate collectors used as roof covering (Energie Solaire SA).

Figure 36:Façade integration of unglazed flat plate collectors used as façade cladding.

The structure and appearance of evacuated tubes somehow limit their integration possibilities into the envelope itself, but applications like balcony eaves or sun shading elements are open.

Figure 39:Evacuated tubes collectors used as deck sun shading (RaU Architekten)

Figure 38: Evacuated tubes collectors used as balcony eaves

Figure 40:Evacuated tubes collectors used as glazed roof sunshading (left: inside view, right:outside view)(Dubendorf Residential building, Beat Kaempfen 2008).

Sun shading applications are also possible for flat plate collectors, but their thickness and water connections can be problematic, therefore PV is usually preferred.

In very hot climates, double roof systems providing horizontal building shading and producing energy could be very effective for minimizing both building heat loads and energy consumption. PV systems can be perfect for this kind of application, but vacuum tube systems used for solar thermal cooling could also be a very effective, and architecturally attractive solution , yet not explored at present.

Figure 41:Examples of double roofs conceived to reduce building heat (a: double tin roof in Arizona architect n.a; b and c: double roof on a private house in Arizona (Architect Judit Chafee, credits Marja Lundgren).

7. Supportive tools and methods for solar active technologies integration in cities:

7.2. EnOB Project Editor

EnOB is an integrated project Editor for Urban-based solar potential analysis tool. It enables the simulation of solar irradiation totals in freely defined time periods together with the shading and solar hours, in each case on the district scale (Hendel S, Voss K , 2017). Unlike solar maps, which are limited to display solar irradiations for roof surfaces, the vertical and inclined surfaces are included by the EnOB solar potential analysis system. The simulations are useful for investigating structural changes in existing or new building schemes (Hendel S, Voss K , 2017).

Figure 42:Java applet startup window (Hendel S, Voss K , 2017)

The EnOB Solar Potential Analysis system generates three simulation: the solar hours, the shading and the solar irradiation, on the basis of a simplified 3D model witch is created directly using predefined elements. Direct and diffuse radiation are taken into account in the calculations. However, only the shading from direct radiation is taken into account for simplification purposes. The reflections from surfaces are ignored (Hendel S, Voss K , 2017).

The software functions

The Project Editor window is simple and consist of few buttons. A district model is assembled from preconfigured buildings.

The Edit Window is located in the center. The menu bar above the Edit Window contains the buttons for editing the project. The Project Editor enables to import a template graphic – see Site Plan, insert buildings using a wizard, calculate the solar hours, shading and solar irradiation, as well as save and export projects. Below the Edit Window are buttons to change the view of the model. The two buttons at the lower left edge can be used to toggle the display in the Edit Window between the 2D view (Site Plan) and the 3D perspective (Site 3D). The five buttons in the right-hand corner below the Edit Window – Zoom out, Zoom in, Pan view, Zoom window and Zoom to fit – enable to change the display view (Hendel S, Voss K , 2017).

The right column next to the Edit Window displays additional information about the project or a selected item.

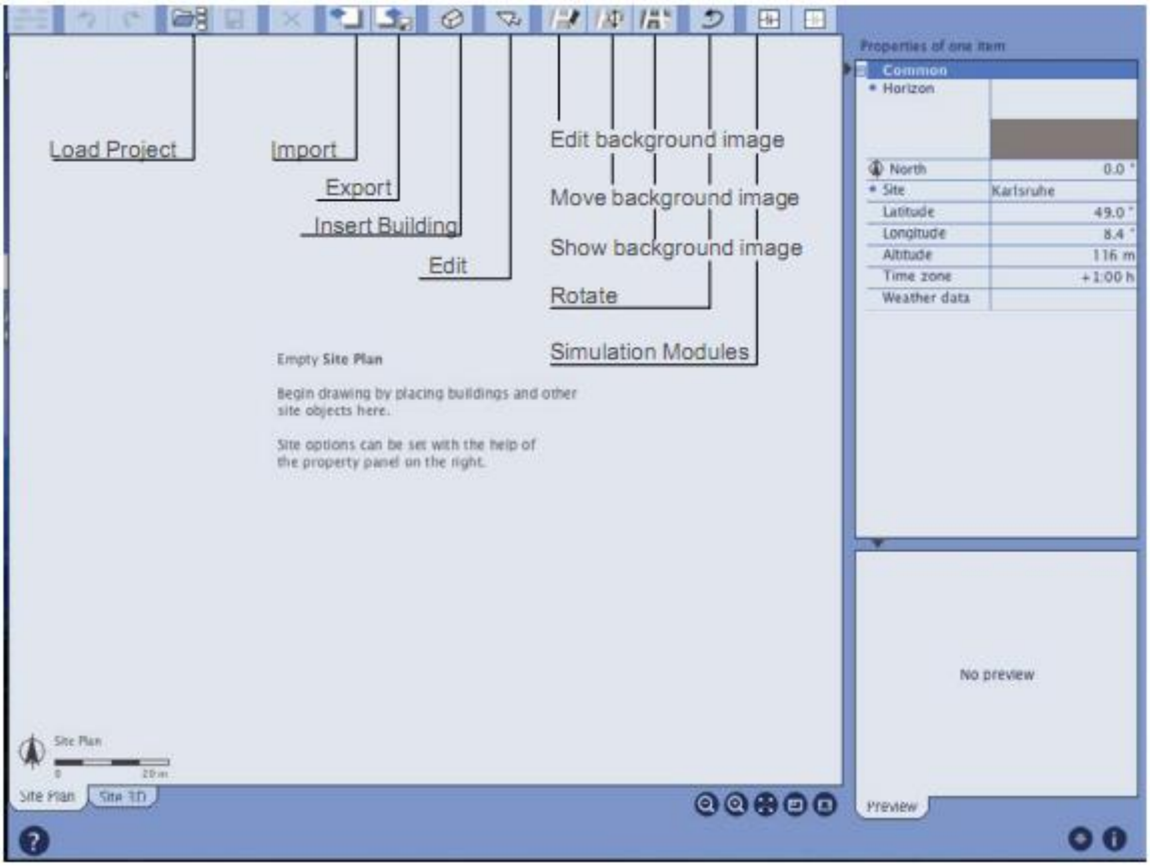


Figure 43:Buttons and basic functions in the EnOB Project Editor. (Hendel S, Voss K , 2017)

Site Plan

The Edit background image button is used to import and scale a site plan that can be used as a basis for drawings. The imported image can be moved at any time using Move background image or replaced using Edit background image.In the 2D view, the site plan is always located on the upper level and hides the calculation results. However, it can be hidden using the Show background image button (Hendel S, Voss K , 2017).

The background image needs to be scaled using a reference length. The reference length is setteled by marking a distance with a known length on the imported background image. After setting the reference length by simply clicking it with the mouse, it needs to be assigned a length in metres in the menu below (Hendel S, Voss K , 2017).

The Project Editor automatically and equally scales the stored image based on the details provided for the reference length. The imported template can be changed at any time using the Edit background image button and moved using the Move background image button (Hendel S, Voss K , 2017).

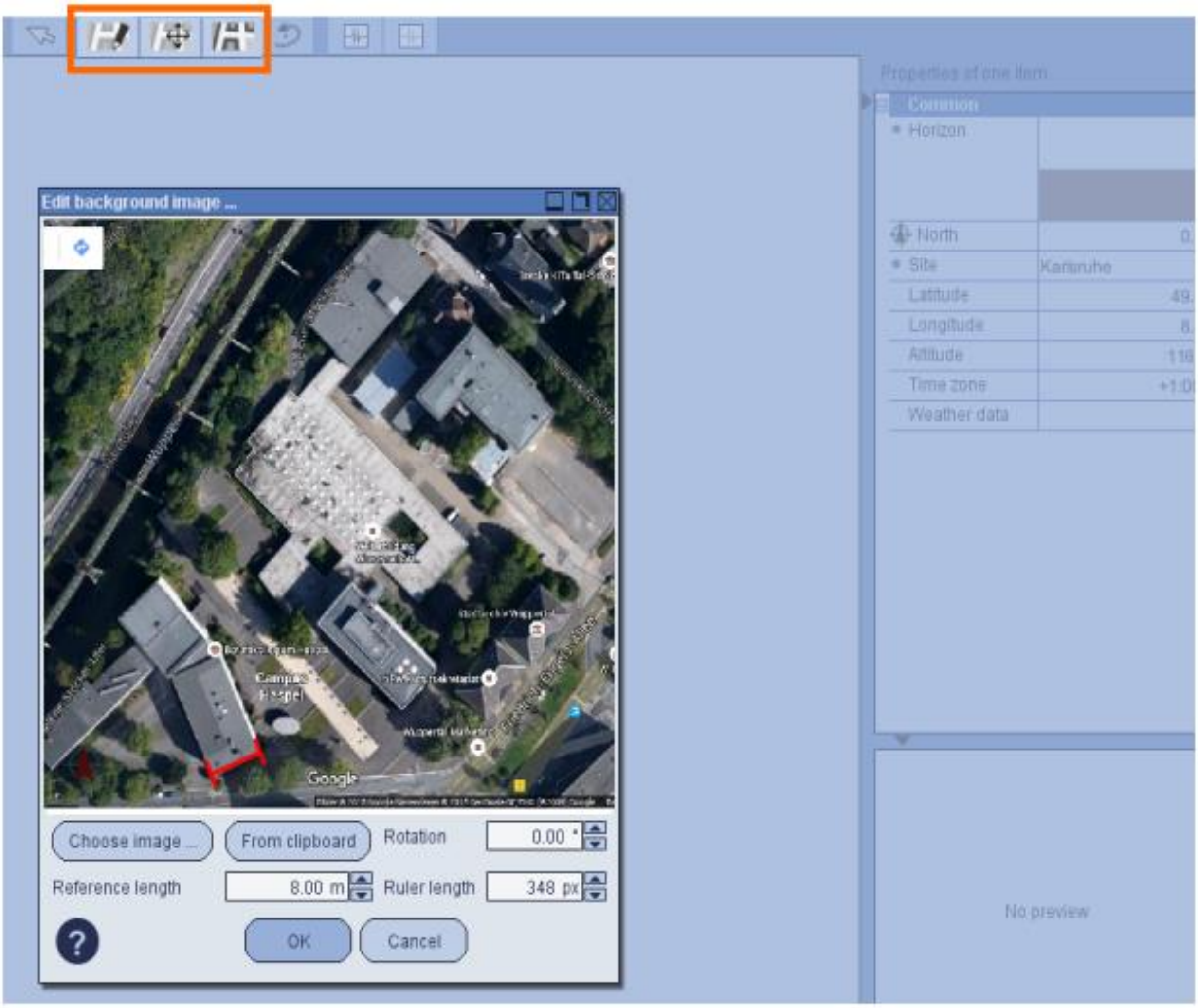


Figure 44:Scaling an imported background image using a reference length (Hendel S, Voss K , 2017)

Inserting buildings

The 3D model of a district is composed by assembling pre-defined buildings. Clicking the Insert building button opens the wizard for creating a new building.

As shown in Figure 4, four different buildings types can be configured. The different building types are defined by the following information (Hendel S, Voss K , 2017):

- Basic building: Building width, Building length
- Block building: Building width,Building length, Main building depth, Lateral building depth, Lateral building count, Lateral building spacing, lateral building length
- Linear building :Here you can draw L-shaped lines with the correct width and length on the floor plan or Set any number of points (outer corners of a block) on the plan (after completing the configuration wizard)
- Free form building : Set as many points as required (external corners of the building) on the plan (after completing the configuration wizard)

After selecting a building form, the building dimensions are queried in the configuration wizard for basic and block buildings. This step is skipped when creating linear and free form buildings since the basic form of the buildings is drawn on the floor plan after the additional configuration.

With the exception of basic buildings, all building types can only be configured with a flat roof. Basic buildings can be created with flat, monopitch, hipped or pitched (gable) roofs.

Step 3 of the configuration wizard, which is shown in Figure 5, is the same for all four building types and queries additional building properties. Here you can give the building a name, which is essential for clarifying the later calculation results (Hendel S, Voss K , 2017).

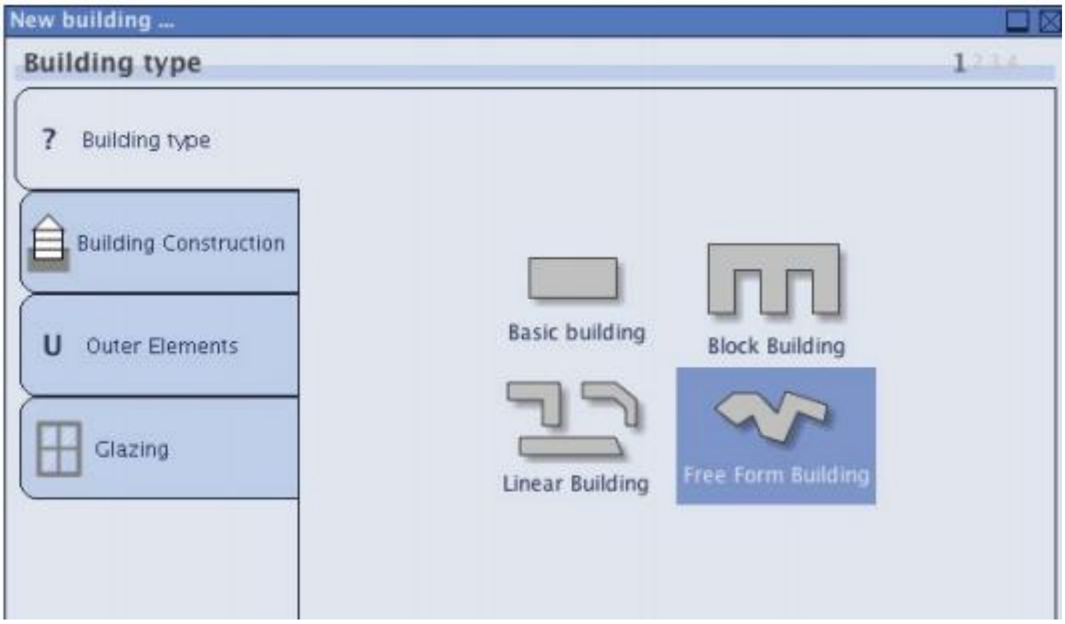


Figure 45:Wizard for configuring new buildings. This window opens by clicking the Insert building button. (Hendel S, Voss K , 2017)

Depending on the type of building, the building dimensions on the floor plan can be defined on the floor plan or by entering the dimensions in the configuration wizard. The building height for all buildings is determined from the Number of levels, Level height, Slab thickness and the Roof height. The various information relating to the building height is queried in the third step of the configuration wizard (see Figure 5). No other properties need to be processed for urban-based calculations. These are aimed at possible other calculation modules (Hendel S, Voss K , 2017).

Figure 46:Step 3 of the configuration wizard for inserting new buildings (Hendel S, Voss K , 2017)

Saving and loading models

Projects can be saved in EnOB Solar Potential Analysis in the Project Editor or can be exported in the software's own .lnb file format or as an .xml file.

In the current project development stage, it is possible to export the created project but it is not yet possible to re-import the exported file. A project can only be saved in the Project Editor. Here you can also create new folders to organise the saved project files. The My Projects, Public, Developer and Share levels have been created for storing projects. This structure stems from an EnOB Solar Potential Analysis development stage that was still linked to an online learning platform and was aimed at facilitating the exchange of project data within working groups or seminars. It is currently not possible to exchange project data (Hendel S, Voss K , 2017).

A calculated false colour image can be exported as a .png, .jpeg, .svg, .pdf or .eps file by clicking the "Export – Export current image" button.

Simulations

The EnOB Solar Potential Analysis system enables to simulate the shading, daily solar hours and solar irradiation on an urban scale. For all calculations, only the shading from direct radiation is taken into account and reflections from surfaces have no influence on the result. The underlying calculation algorithm is explained in more detail under the Functionality heading. The program creates a calculation grid for all surfaces with a 1x1 metre grid (Siems T,Simon K, 2016).

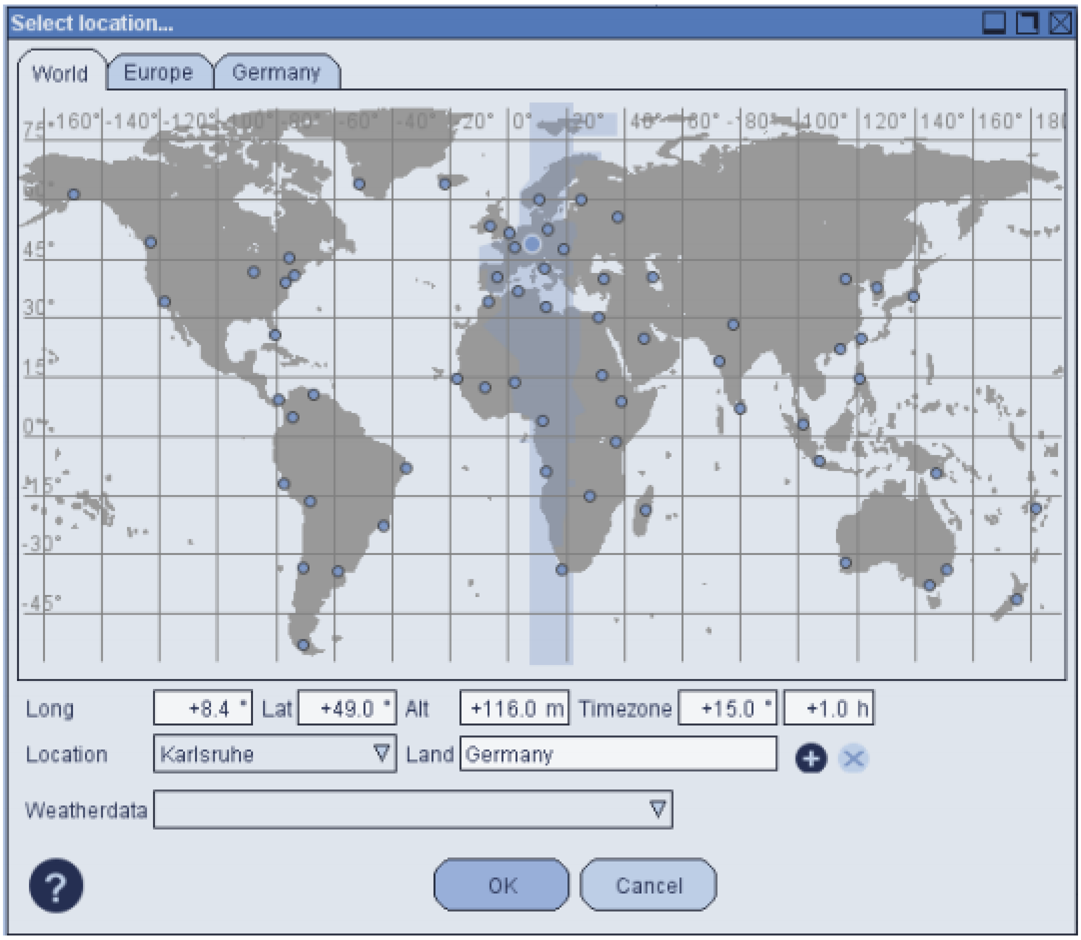


Figure 47: Selecting weather data. (Hendel S, Voss K , 2017)

The simulations are location-based and refer to an online weather database from the US Department of Energy at https://energyplus.net/weather. For further information on selecting weather data, see Solar hours, Solar irradiation, Shading and Figure 6.

Based on a previously created, true-to-scale 3D model, the simulations can be started by clicking the Calculation modules button in the 2D view (Siems T,Simon K, 2016).

Solar hours

The daily hours with direct solar irradiation can be determined with the Solar hours simulation tool. The simulation result is displayed as a false colour image with a scale (h/d).

Clicking the Calculation modules button opens a menu window where you can select the desired simulation. Clicking the Play button starts the Solar hours module.

The hours of sunshine are always calculated for one specific day, which can be selected via a displayed menu window. The location of the model is set by clicking the Weather data button (Siems T,Simon K, 2016).

The calculated false colour image can be exported (see Save and Load).

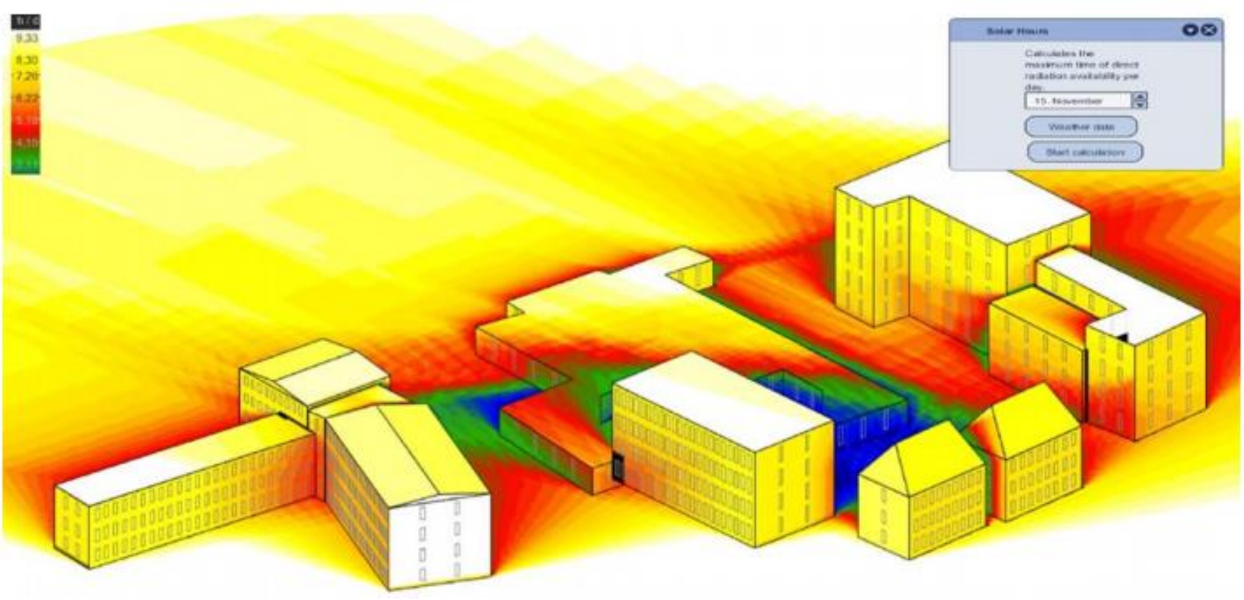


Figure 48:Simulation result for “Solar hours” as a false colour image. (Hendel S, Voss K , 2017)

Shading/ Solarization

In the Shading/Solarization calculation module, shading created by direct solar radiation can be depicted as single images for selected time points or additively as superimposed individual images (see Figure 9). The module enables you to calculate the shading either in 1-, 2-, 5-, 10- or 20-minute intervals during the course of a specific day (daily) or during the course of the year at a specific time in 1-, 2-, 5- , 10- or 20-day intervals (annually) (Siems T,Simon K, 2016).

The time period and calculation interval are defined in the selection menu for the simulation module (see Figure 9).

The shading cannot only be depicted as a still image but also played as an animated sequence.

The greyscale images generated here can be exported (see Save and Load).

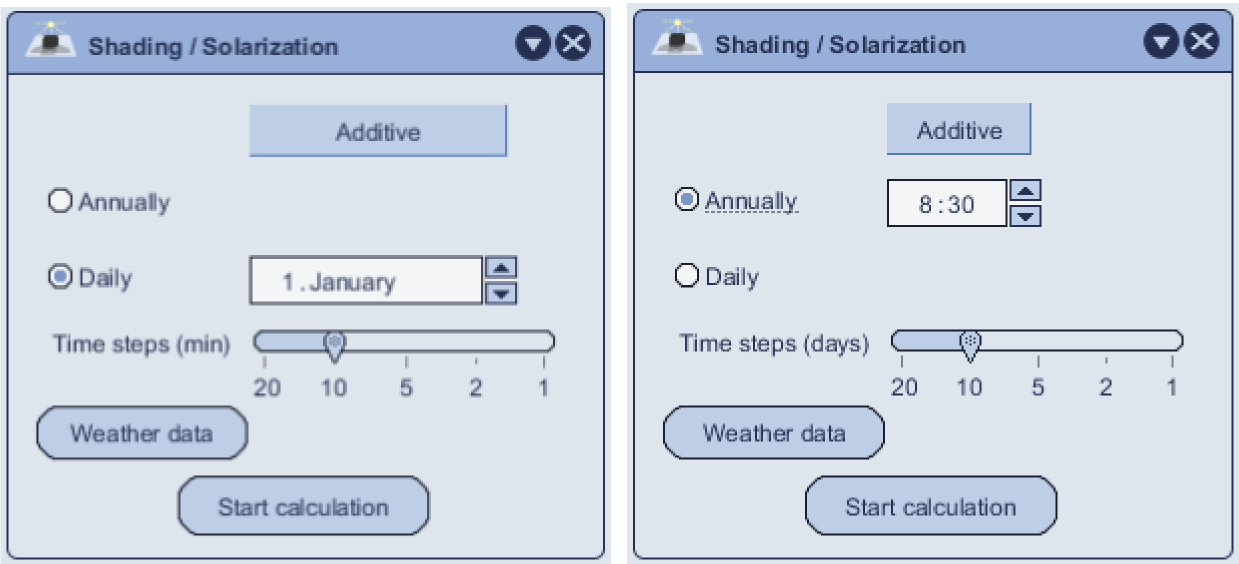


Figure 49: Selection menu for the Shading/Solarization calculation module (Hendel S, Voss K , 2017)

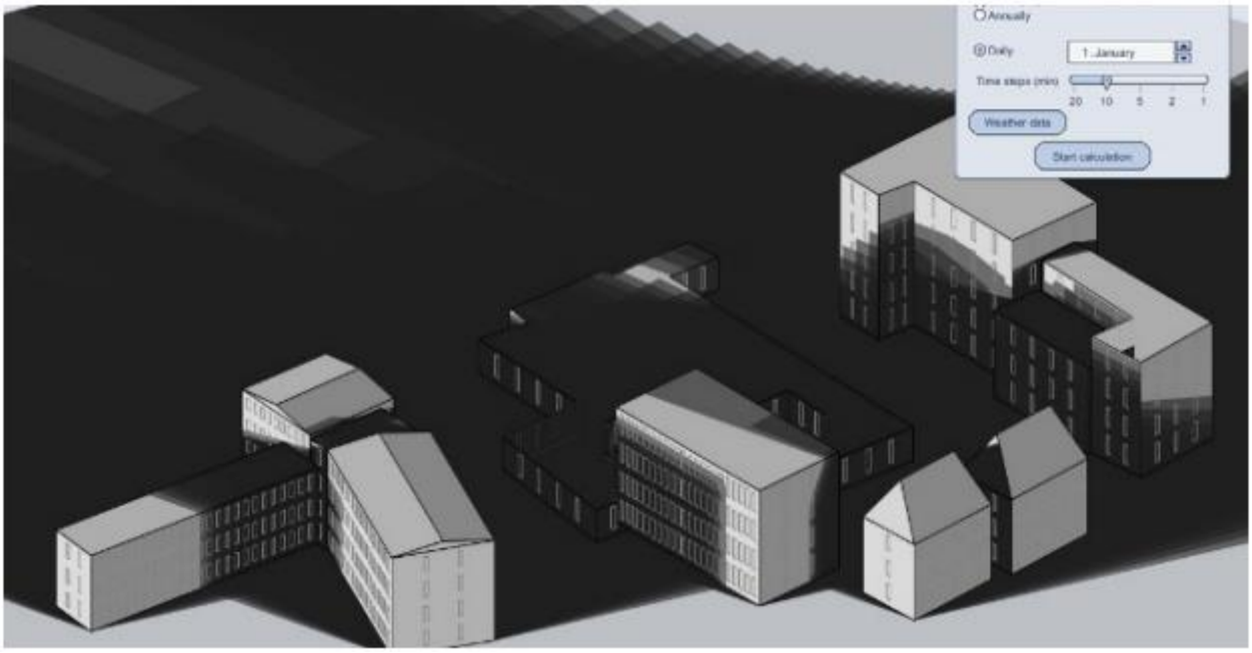


Figure 50: Simulation result for Shading/Solarization with the additive depiction with grey-scaling (Hendel S, Voss K , 2017)

Solar irradiation

In addition to simulating the solar hours and shading, the solar irradiation on all surfaces built in the model can be determined as total values for selected periods.

Clicking Calculation modules – Solar irradiation opens a menu window in which the calculation can be modified (Siems T,Simon K, 2016).

Here we can select a single day with an exact date for the calculation period or a single week, a typical week or an extreme week in spring, summer, autumn or winter. In addition, it is also possible to calculate the solar irradiation for one year (Siems T,Simon K, 2016).

Before the calculation can be made by clicking Start calculation, you will first of all need to specify the location of the model by clicking the Weather data button. For the selected location, the corresponding radiation data from the climate database will then be automatically loaded for the calculation. If the weather data is not manually selected, a pop-up window will ask if the standard weather dataset should be used when starting the calculation. The result is displayed as a false colour image and as a numeric value in the .csv format. The simulation result can be downloaded as a .csv file by clicking the Export button in the calculation menu window (Siems T,Simon K, 2016).

In the exported file, all surfaces of all modelled buildings are listed according to their orientation and plane with their size and the irradiation averaged over the respective grid listed as total or area-specific values (the calculation grid is 1x1 m).

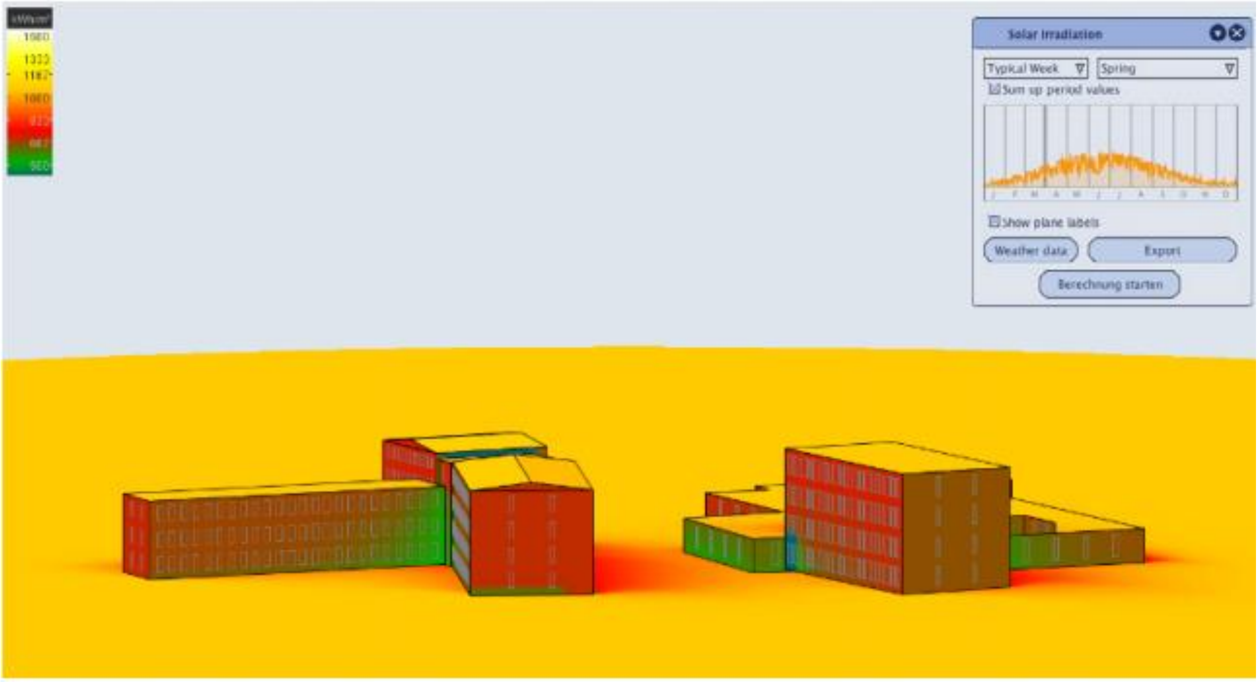


Figure 51:Simulation result for the solar irradiation depicted as a false colour image for a one-year calculation period (Hendel S, Voss K , 2017)

Limitations of the software :

The model can only be used for flat terrains. In order to correctly depict the horizon shading caused by surrounding hills, this shading needs to be recreated with the aid of added buildings.

7.3. The LESO-QSV (QUALITY-SITE-VISIBILITY) Method:

This approach has the vision of settling "smart solar energy policies that are able to preserve the quality of existing urban contexts while promoting solar energy use" (Munari Probst, MC., Roecker, C., 2015). Mapping the architectural "criticity" of city surfaces, and crossing this information with the city solar irradiation map (LESO-QSV cross-mapping). The obtained cross-mapping evaluates the interest/difficulty to use this surface for solar energy production, helping setting priorities of intervention, planning oriented subsidies for urban solar policies.

Allowing solar integration even in most sensitive contexts while preserving architectural quality. Poor integration due to low coast investment can discourage future users of solar energy. The decision of postponing the operation is the most rational until appropriate funds are secured. By contrast, a good integration project can be among the strongest drivers for solar urban integration.

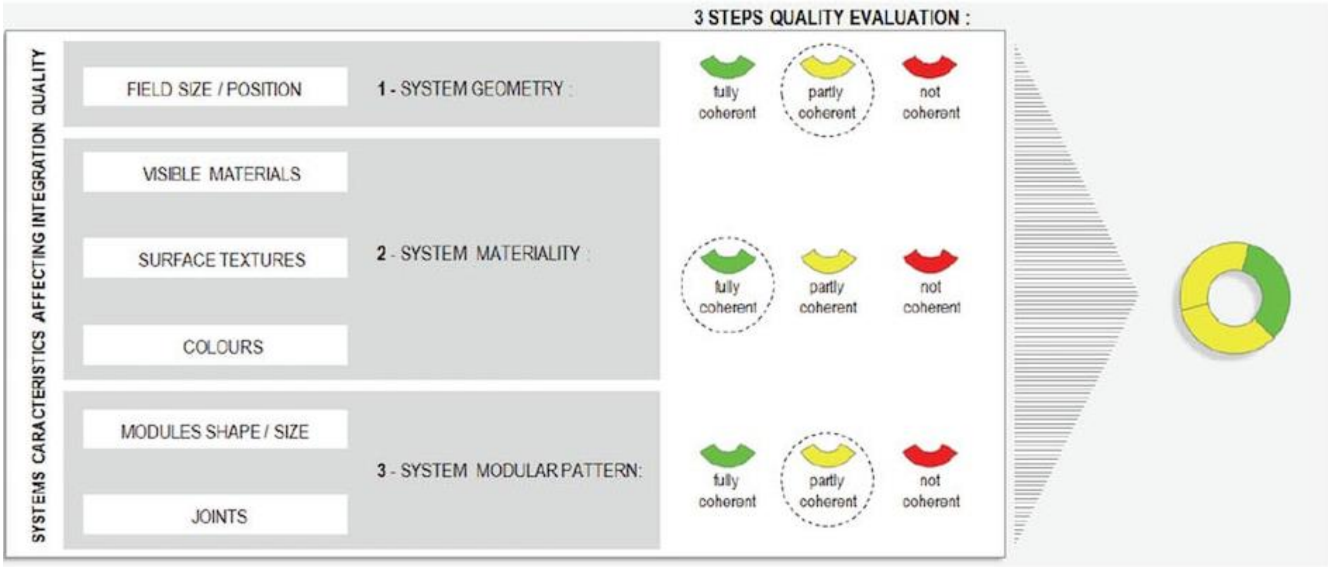


Figure 52: Quality evaluation steps and resulting graphic representation (Munari Probst, MC., Roecker, C., 2015).

The LESO-QSV method clarifies the notion of architectural integration quality. Proposing a simple quality evaluation method, based on a set of three criteria derived from pre-existing literature[1] (Munari Probst, MC., Roecker, C.).

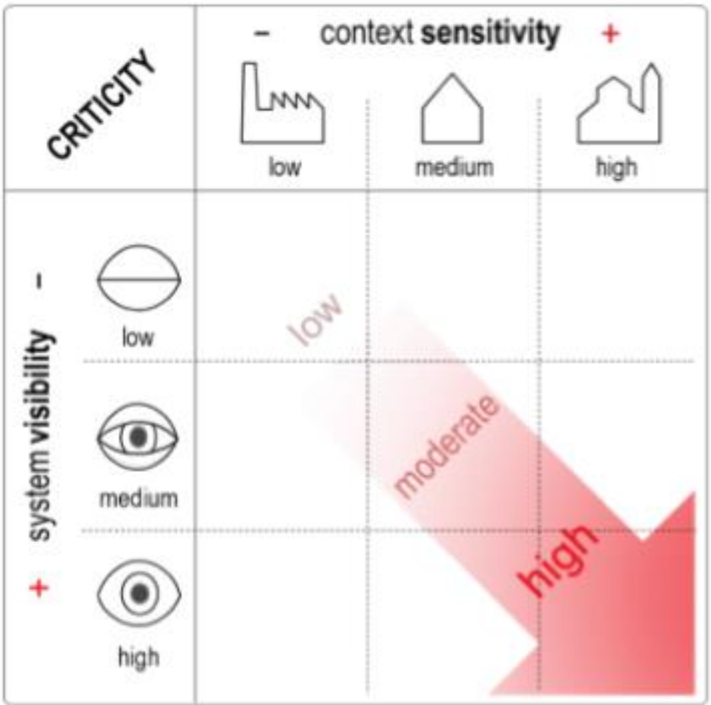


Figure 53:"Criticity" grid, crossing urban context sensitivity with building surfaces visibility. (Munari Probst, MC., Roecker, C., 2015)

Figure 54:Different context sensitivities (high; medium; low). (Munari Probst, MC., Roecker, C., 2015)

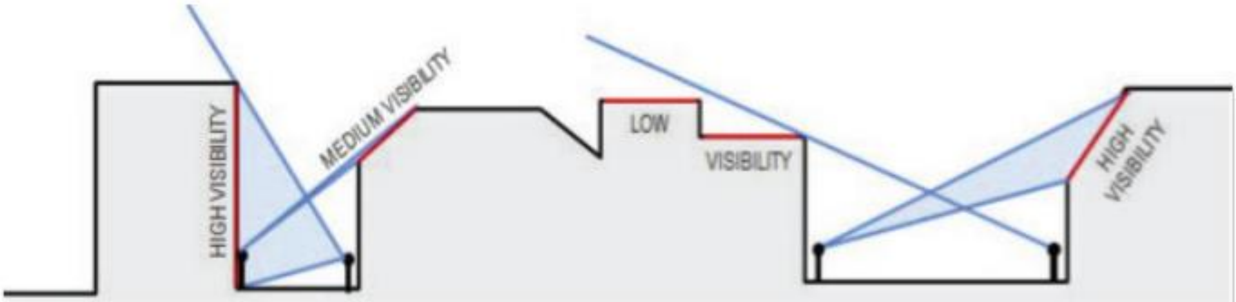


Figure 55:different levels of close visibilities. (Munari Probst, MC., Roecker, C., 2015)

Based on the notion of architectural "criticity" of city surfaces (LESO-QSV acceptability) witch is defined by the sensitivity degree of the urban area. The approach helps decision makers to set and implement local acceptability requirements it helps authorities set and implement local acceptability requirements,

The visibility criteria: the solar system is planned and by its Visibility (close and remote) (see Figure 2 left) from the public domain. The more sensitive the urban area and visible the system, the higher the needed quality.

In practice, nine "criticity" situations will result from the sensitivity visibility grid. Authorities should decide the integration quality level for each situation considering the geographic and social specifities of the area.

In order to facilitate the elaboration of the mentioned "criticity maps ", a PhD study is exploring ways to combine GIS (Geographic Information System) information to automatically assess city surfaces visibility.

An "application package" for Swiss municipalities willing to use the method to set and implement local acceptability requirements in their environment will be proposed by the end of August 2016.

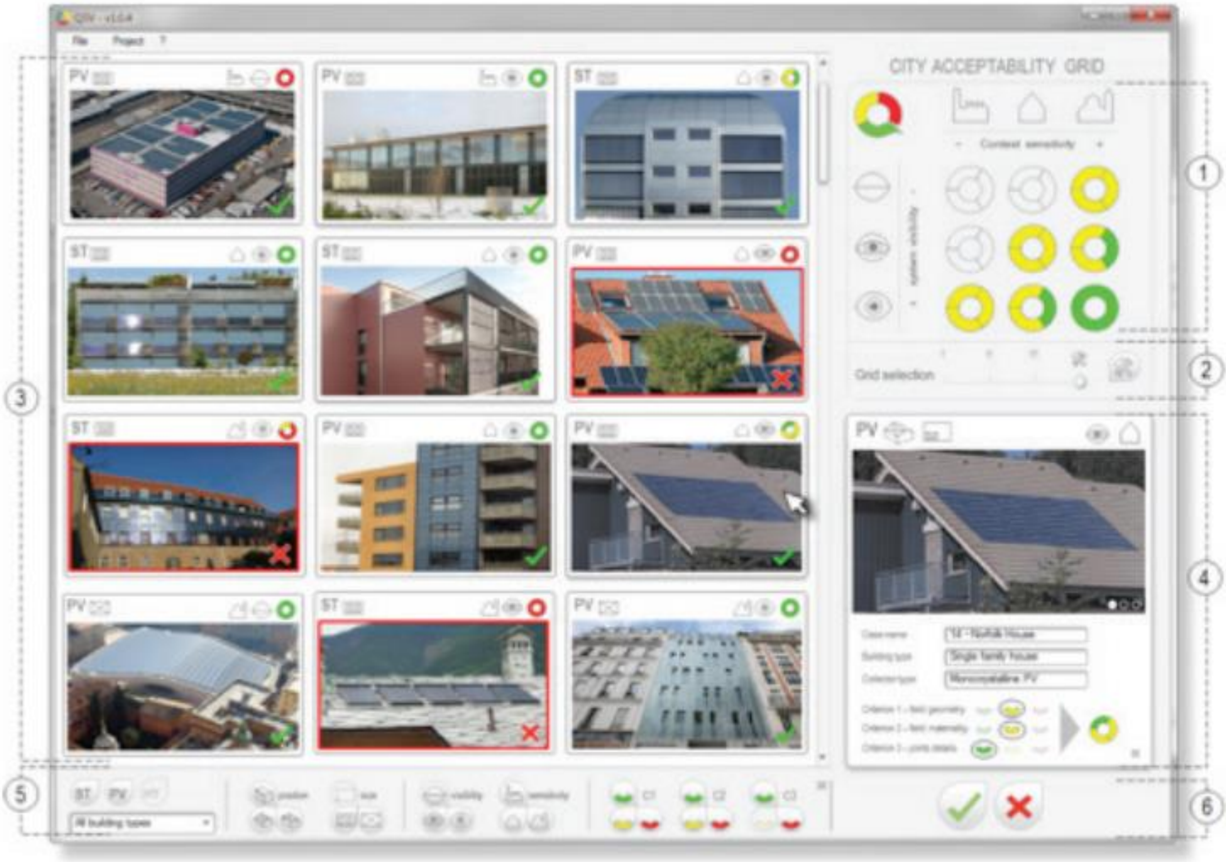


Figure 56 Main screen of the LESO QSV GRID program (Munari Probst, MC., Roecker, C., 2015)

1 - **Acceptability grid of the specific city:** i.e. required integration quality for each criticity level (system visibility; context sensitivity). These are the criteria to be met for the installation to be accepted.

2 - **Acceptability grid setting bar (for Municipality use only):** Integration requirements can be selected by using pre-established grids (more or less severe) or built to measure.

3 **- Integration examples showcase:** A database of more than 100 cases is shown according to the selected filters setting (Krippner, 2000). This showcase is meant to help Municipalities set a convenient acceptability grid by showing the impact in acceptancy of pre-defined sets of quality requirements; work as a model for authorities on how to objectively evaluate integration quality; and inspire architects, installers, building owners, etc.

4 - Case details window: The window appears while clicking on a specific case. The detailed evaluation of quality becomes visible together with other more precise information and additional pictures of the case.

5 - Filter bar: The case studies can be filtered according to solar system type, position, dimension, context sensitivity, system visibility, and integration quality.

6 - Accepted / not accepted cases button filters

Chapter five: conclusion and recommendations

1. Conclusion

Algeria adopt the republican governance but still modeled under the inherent French system. It is a centralized model of governance concentrated in the capital Algiers. Thus, energy policy is being performed of a top down model. The decisive ministries are mostly stuffed with representatives of oil and gas utilities. Which explains the domination of the Hydrocarb's industry on the design of the energy policy of the country. The centralized system does not grant any autonomy to local provinces" wilaya" in term of decision making. Since their governors are directly appointed to the president. As a consequence of this big centralization, the bottom up innovations of the sector are hardly accepted.

Cities have a great potential in shifting energy policies toward a more sustainable pathway. Allocating such responsibility to urban actors is a universal trend. Unlike some other countries, cities cross Algeria still struggle to position themselves in the design of policy alternatives to achieve energy transition under the domination of powerful national actors.

Algeria, an urban country with 71.9% of total population (2017) living in cities and an annual rate of urbanization of 2.26% (2015-20.). With a great solar potential, the southern Sahara represents 87% of the global area of the country with only 9% of the population. In order to develop harmoniously the entire territory, the country produced a legal arsenal to create a set of ranging from national to local. As part of the implementation of its strategy, A National Spatial Planning Scheme "NS" Act, was enacted in 2010 and approved for a period of 20 years. With a sustainable development perspective, the NS is based on three ends:

- The demographic deadline: it is perfectly programmed with the arrival of the bulk of the wave of job seekers.
- The economic outlook: competitiveness and the upgrading of the territories as a corollary. It is the creation of the free trade area and the entry into the WTO.
- The ecological deadline: which requires the preservation of natural and cultural capital in a situation of water stress and scarcity of soils and where competition is increasingly strong between use and sustainability of resources.

The transmission of this ambitious policy to city scale seems problematic.

In order to localize the gape that blocks the transmission of national policies to city scale, a global approach analysis of the different urban planning and environment protection instrument was presented. It was highlighted that there is a conflict of scale between the national and the local level. The national instruction seems too ambiguous to be translated on city scale. The stigmatization between environmental dimension and local planning instrument MPU and SOP is another barrier of the effectiveness of the planning instrument in practicing the environmental directives on city scale.

A second analysis was focused on the architectural scale. It is an examination of the legal texts that refer to environment interfering with the built environment addressing the sun, light, wind, air, noise, lighting, thermal comfort, energy. With a purpose to cover all the aspects of regulatory framework, a content analysis was applied. The first section concerned the building sector while the second one treated renewable energy and energy efficiency preoccupations. The analysis demonstrated that legal synergy between the sectors is restricted to a set of methods of calculation and standards that can be applied only at a late stage of the design.

At a local scale, the integration of solar systems in the urban context requires careful planning. Preserve the quality of pre-existing urban areas while promoting solar energy use needs to support city experts with a set of methods of solar energy planning is a must. This part of the thesis present samples of qualitative and quantitative tools that can be used by city experts the integration of solar energy without a need of complicated analysis or external expertise.

The present work is a contribution that identifies some barriers of implementation of renewable energy policy at urban scale. It will enable a specific localization of strategic areas of intervention to unblock the energy transition in cities under the top down model of governance.

2. Recommendations

The interaction of actors in the energy chain in Algeria is broken. Decisions are made centrally and are scaled down to the communal level for execution. The municipality plays a minor role and is ejected from the energy circuit. Through energy governance, we can claim an anticipation in energy management for urban planning. we would be forced to think of a conceptual framework of governance. We need to intertwine different areas of urban concern to build a global vision.

We recommend to categorize the instruments regarding their mission: mentoring; evaluation intervention, financing Identify and associate the different stakeholders and actors at each step of the development of the instruments using a systemic approach instead of the hierarchical. Then, most important factor is to involve the civil society share the vision and take in consideration every input since the city is their living environment.

A specific local instrument auxiliary to the MPU and SOP but with: architectural scale that deals with all the complex problems related to the quality integration of solar energy technologies. Integrated into the instruments of the higher scales relating to the environment in a harmonious manner, it will undoubtedly help the MPU and SOP to better understand the problems of the environment from urban to architectural.

Chapter six: references

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