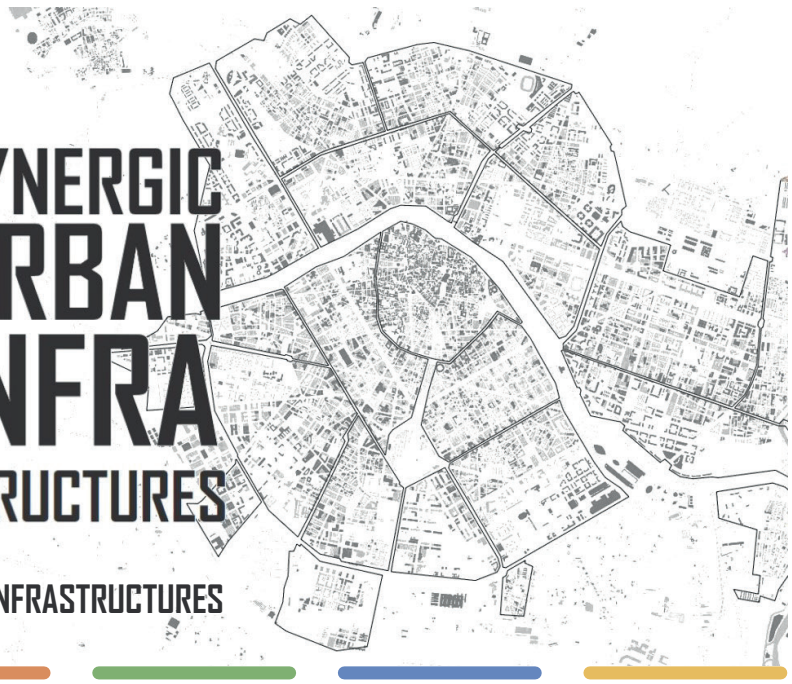
VLC SYNERGIC URBAN INFRA STRUCTURES



VALENCIA SUMMER SCHOOL ON SYNERGIC URBAN INFRASTRUCTURES

Editors: Juanjo Galan Vivas | Luis Bosch Roig

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2.6_ENERGY INFRASTRUCTURES: PRINCIPLES, DIAGNOSIS AND TOOLBOX IN VALENCIA

Juanjo Galan | Associate Professor, Polytechnic University of Valencia

2.6.1. Urban energy infrastructures and the energy team

The energy infrastructure of the city of Valencia and its pilot area (El Grau-Nazaret-Moreras-La Punta) was analyzed by the Energy team as part of their TASK1 during the online phase of the VLC_Summer School. The team was composed by six students from the Technical University of Valencia (UPV) with different backgrounds and levels of expertise. Lilan Cubel, Mohamad Hamdache, Adela Archiles and Amina Zannouti were all students from the bachelor's degree in the fundamentals of architecture, Flora Kannampallil was coming from the master´s degree in architecture and Jose Ignacio del Río was a student from the bachelor's degree in environmental and agricultural engineering.

The urban energy infrastructure can be conceptualized as the material and immaterial components and processes permitting the production and use of energy in the city. Since energy is required in any natural or human process, the energy infrastructure affects all activities and function happening in the city and could be associated to its basic metabolism (Ferrao & Fernandez, 2013; Galan & Perrotti, 2019). Following the logics of a metabolic approach, the flow of energy in the city has usually involved an external production, a transportation, an internal consumption, the dissipation of wasted energy (usually in the form of heat), and different types of emissions (CO2, pollutants, etc.). However, in contrast to the highly linear, inefficient, and fossil fuel-based energy cycles that have characterized traditional cities, new urban paradigms advocate for a more circular and efficient metabolism based on the use of renewable sources (Foster, 1997) and for carbon neutrality as a necessary precondition for climate change mitigation. In this context, energy transitions appear as a systemic and crosscutting transformation affecting all the levels of our daily lives and all the other urban systems or infrastructures. This is precisely why the search of synergies, and the avoidance of conflicts, become critical when dealing with urban energy and why social issues like energy justice or spatial issues like the levels of energy production- consumption associated with different urban patterns or building types becomes not an option but a necessity to be explored in this course.

2.6.2. Task1: workplan and initial information

In order to self-organize their work during the online phase and after attending a series of introductory lectures about the different infrastructures addressed in the course (green, blue-water, energy, mobility, social, and housing), the energy team and their tutor arranged an online meeting to define a preliminary structure for their task, to analyze the provided data and cartographies, to schedule their internal workflow and reviews with the tutor during the online phase, and to divide the work within the team. Two major deadlines were kept in mind during the process: the mid-review (25.08.2023), in which each thematic team would present the state of their work to other teams, and the final submission on the 1st of September 2023.

The availability of adequate, sufficient, and updated information was considered essential to initiate the course, and more critically, to activate an online phase in which students did not know each other (even coming from the same university) and had to start working in topics which were not fully familiar for them. In particular, the energy team was provided with the following information:

- Introductory session to Urban Energy Infrastructures (by Assoc. Professor Juanjo Galan Vivas). As for the other thematic sessions, this session was delivered to all the students of the course through the e-learning platform of the UPV (PoliformaT) and was aimed at providing a basic understanding about the use of energy in a generic city. Later, the energy team was expected to apply and extend this knowledge to the city of Valencia. The session included a lecture of 45 minutes and a short and practical exercise.

- General information about the City of Valencia (available to all teams): This information included the main city plans and strategies as well as basic cartography in different editable formats (shp and dwg), orthophotos, and a manual to visualize and download information from the cartographic platform of the Valencian Region.

- Specific information about urban energy infrastructures and about this infrastructure in the city of Valencia. This information was specifically aimed at the energy team and included European, national, regional, and local strategies, reports, and guidelines for carbon neutral cities, together with additional data and maps about the energy infrastructure in the city of Valencia.

After the initial meeting, the energy team organized their online work into three stages:

- The *stage1* included a literature review, search of case studies, and the development of a conceptual framework including the basic vocabulary and concepts to be used in task1. This stage 1 was carried out during the first week and included two meetings with the tutor, an initial one to discuss the workplan, and a second one at the end of the week to discuss the results. In the meantime, students worked independently, and the assistance of the tutor was only required to confirm some selected case studies.

- The *stage 2* included the analysis of the energy infrastructure in the city of Valencia and the pilot site. This stage was implemented during the second week and included two tutored sessions, one at the beginning and one in the middle to get some support in the elaboration of a conceptual energy model for the city of Valencia. At the end of this week the energy team presented the state of their work to other teams during the mid-review seminar.

- The *stage 3* was implemented during the third and last week of the online phase of the course and comprised the elaboration of a generic toolbox to improve the energy infrastructure of Valencia, and a preliminary identification of potential synergies between the energy infrastructure and other urban infrastructures addressed in the course. Two tutoring sessions were scheduled, one to initiate the stage, and one to make a rehearsal of the final presentation of the elaborated materials.

Students worked autonomously during the task 1, but after detecting an excessive tendency to divide the work into individual subtasks, the tutor encouraged the team to arrange daily only meetings to facilitate the exchange of ideas. These internal meetings were essential to construct a common understanding of the task, of the key concepts and of the expected outcomes.

2.6.3. Results

STAGE 1: A conceptual framework to operate with the Urban Energy Infrastructure

The analysis of the selected literature and case studies led to the decision to approach the energy infrastructure from a metabolic perspective. According to this perspective, by understanding the flows of energy in a city (production, transportation, consumption), it would be impossible to improve its efficient and sustainable use. At this point it became also necessary to develop a common vocabulary to make sure that all the students were operating within the same conceptual framework. What is a 'energy infrastructure'? what is a 'more circular energy metabolism'? what are energy production and energy consumption? is the city a homogeneous structure or a collage of different urban fabrics with different energy profiles? Which actors or stakeholders were involved in the metabolism of the energy in one city? How could these actors contribute to a positive energy transition? Which kinds of physical transformations and changes in the ways of living can support that transition?

The main outcome of this stage was a conceptual model in which the key components of the energy infrastructure of Valencia were identified: energy production (inflows), energy consumption (considering different sectors or activities, urban typologies, and consumers' socio-economic profiles), and emissions. As an overarching framework, the students positioned the network of actors and governance systems affecting the performance and evolution of this energy structure (international, national, and local regulations, energy suppliers and other economic actors, media, and the citizens). This model was perceived as an empty structure to be filled with specific information and data from the city of Valencia.

STAGE 2: An energy model of the City of Valencia: an analytical and diagnostic tool to support decision making and definition of solutions

With the available information, the energy team was able to concretize and fill in their model in the city of Valencia. Sometimes the information was very precise, and some other times the students had to make considerable extrapolations from different sources (Figure 2.6.1). As displayed in Figure 2.6.2, the result was a qualitative model which helped students understand: (1) the main types of energy currently consumed in Valencia. This analysis revealed a high rate of consumption of non-renewable energy. Secondly, the model analyzed how this energy was consumed in different sectors (private and public transport, domestic uses, services, etc.) and how different urban typologies and socio-economic profiles could be associated with different levels and patterns of consumption. In addition, the study made evident to the students the low rates of self-production and self-consumption of energy in the city. The 'emissions' component of the model disclosed the inefficacies in the energy infrastructure and the liberation of greenhouse gasses and pollutants in the city because of the use of fossil fuels. Finally, the analysis of the actors and governance system of the energy infrastructure was essential to understand the main stakeholders and frameworks involved in the functioning and future evolution of the energy infrastructure. With this information in mind, the students were able to identify the main challenges affecting the "production/consumption/emissions/actors components" of the energy system.

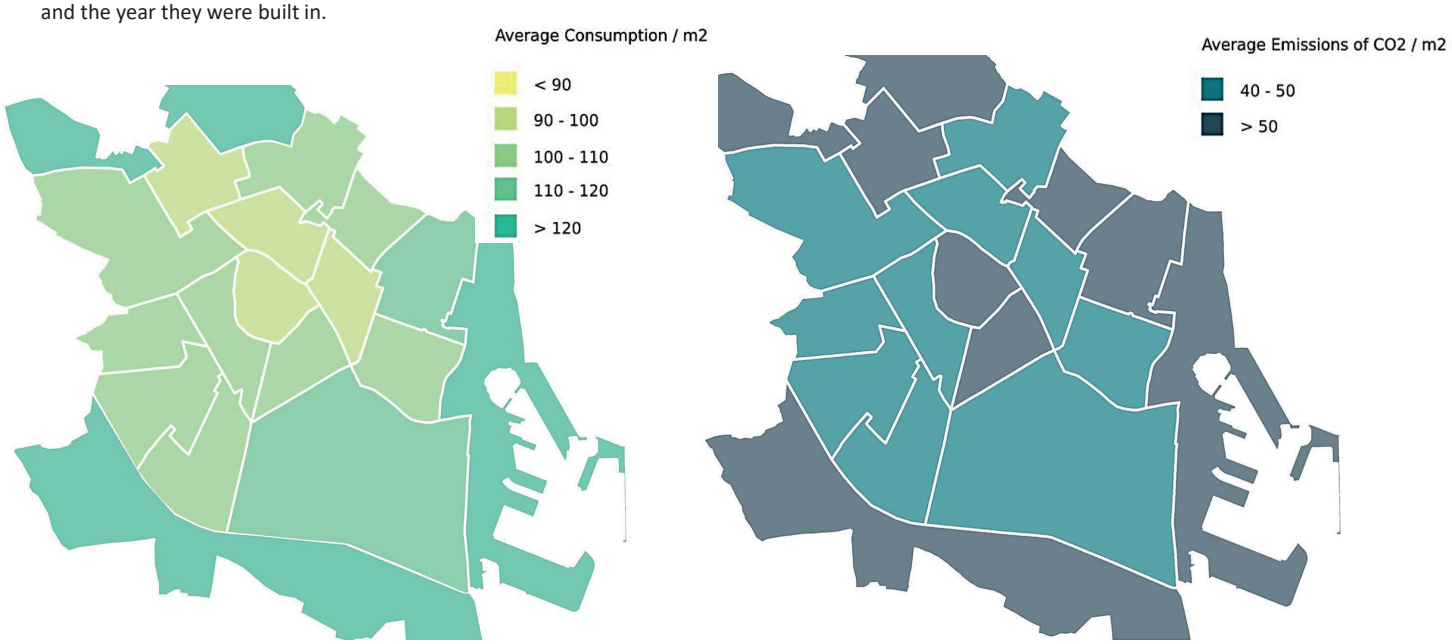
As displayed in Figure 2.6.3, the identification of actors was an important step to detect potential collaborators and resources for an energy transition in Valencia. As showed in Figure 2.6.4, the existing energy objectives and goals included in the Mission for Carbon Neutrality Valencia 2030, were also fundamental inputs to help the students align their work with the city plans.

STAGE 3: A generic toolbox for urban energy infrastructures

Based on the challenges identified in the energy model (Figure 2.6.2) and in the Carbon Neutrality Mission of the city of Valencia, the energy team proposed a more elaborated and interconnected map of challenges (Figure 2.6.5). This map was essential to define a generic toolbox (Figure 2.6.6) organized around the for components proposed in the energy model (production, consumption, emissions, and actors). The specific tools included in each sector were proposed after a second and extended analysis of the available literature. Interestingly, some of the tools were related to technical solutions, but many others were connected to changes in ways of living, urban transformations, etc. Finally, and to prepare the energy team for their interaction with other teams, the students elaborated a preliminary analysis of the potential synergies of the energy infrastructure with other urban systems (green, water, mobility, social, and housing). This step was considered crucial to activate the inter-infrastructural way of thinking that was going to be required during the face-to-face phase of the course (Figure 2.6.7). According to the course schedule, the energy team, as all the other teams, presented the results of their task1 during the first day of the onsite week in Valencia.

ENERGY CONSUMPTION AND EMISSIONS - VALENCIA PER DISTRICT

In Valencia, buildings with narrow, elongated plots and low-rise structures (1-3 floors), commonly found in *village districts*, exhibit elevated rates of consumption and CO2 emissions, attributed to their *"energy-inefficient structure ¨* and the year they were built in.



SOURCE: OWN BASED ON CARTO MAP

Figure 2.6.1. Energy consumption and emissions per district in Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

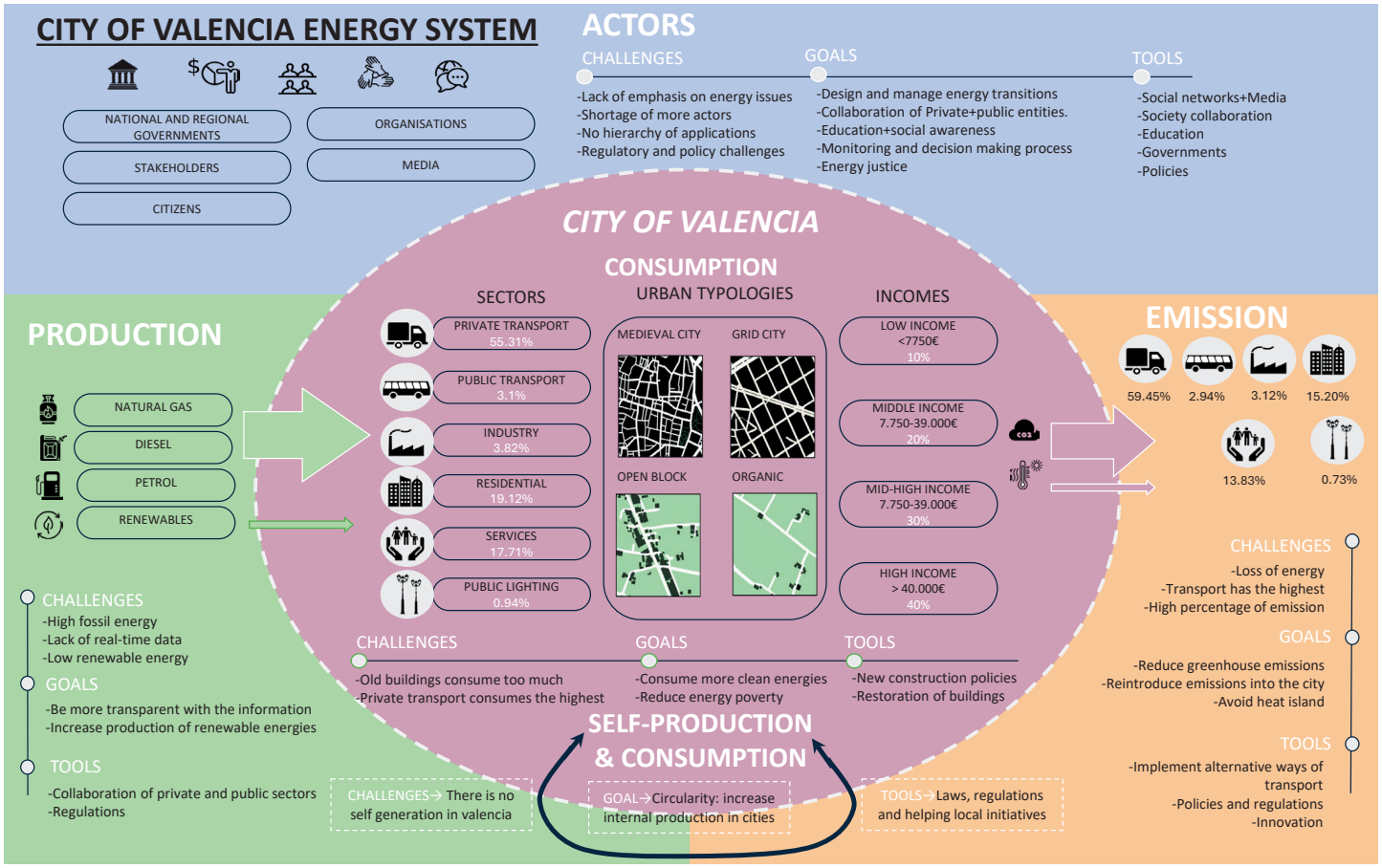


Figure 2.6.2. Energy model for the city of Valencia Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

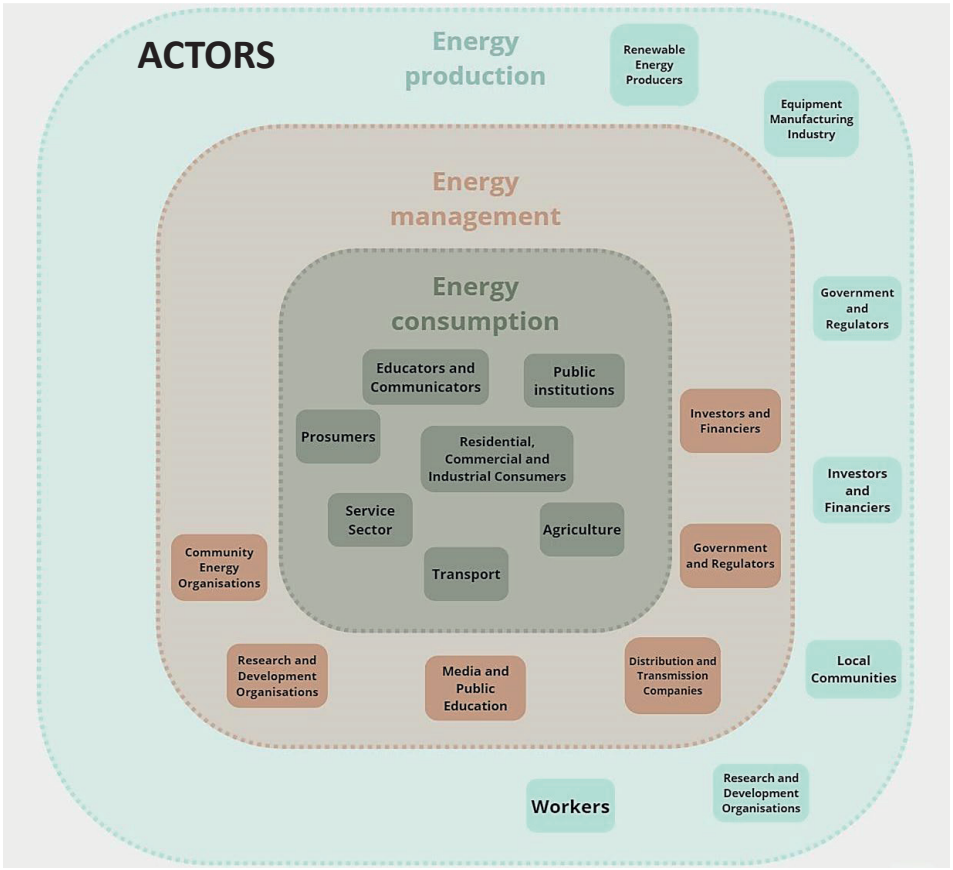


Figure 2.6.3. Main actors involved in the functioning of the energy infrastructure in Valencia Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Rio, 2023)

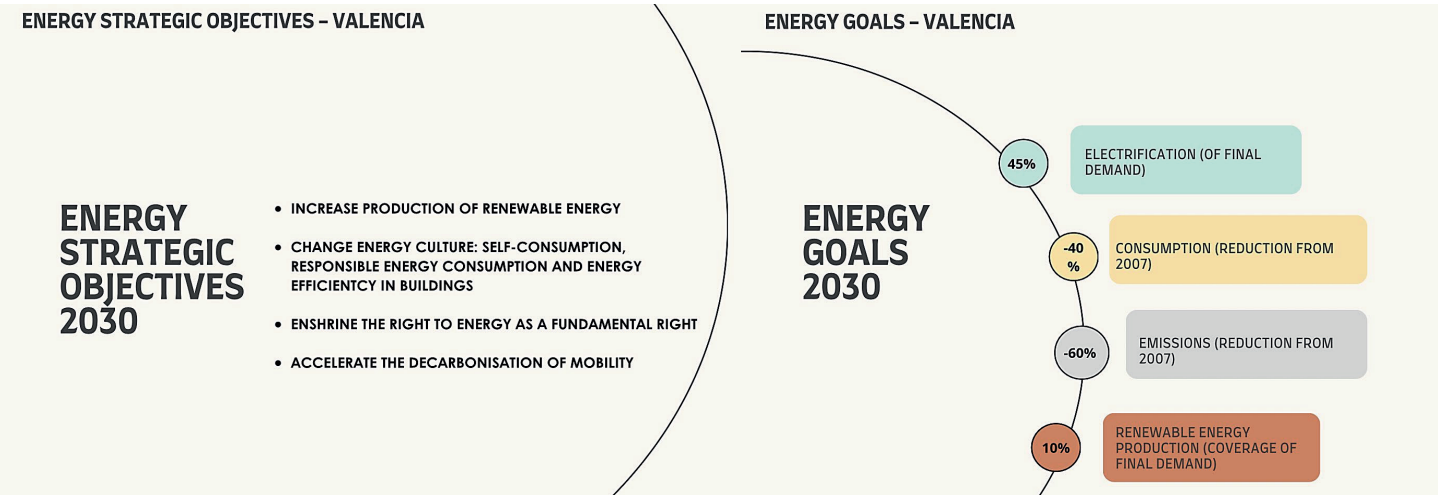


Figure 2.6.4. Main energy goals defined in the Mission for Carbon Neutrality Valencia 2030 Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

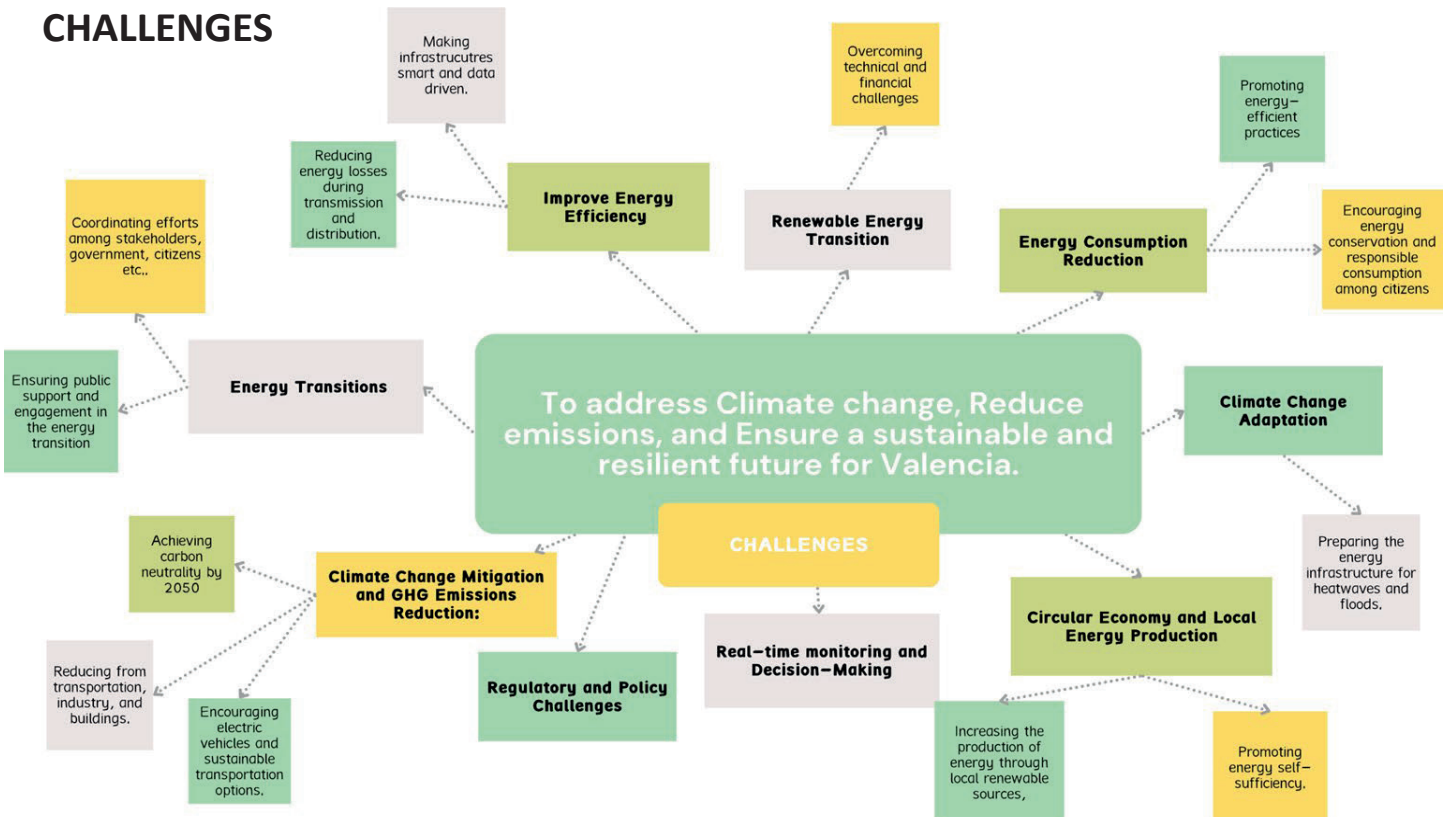


Figure 2.6.5. Main challenges affecting an energy transition in Valencia Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

2.6.4. Final reflections

The conceptual model was probably the most valuable outcome and a key instrument to evolve in the development of task1. However, it was difficult to produce it due to the tendency of the students to urgently collect and combine solutions from different sources without understanding the real functioning of the whole energy infrastructure. In this regard, the conceptual model was essential to structure the analysis, to identify and understand the magnitude of the challenges and potentials (diagnosis), and to select the solutions in answer to the analysis and diagnosis. Moreover, the model was especially useful to promote a genuine Challenge/Problem Based Learning process grounded in a real understanding of the addressed system (energy system in this case). Moreover, considering the time given and that the energy infrastructure was not very familiar for any student, the students were able to qualitatively identify the key issues affecting urban energy infrastructures and to get some basic data to support evidence-based decisions.

Finally, regarding the online work, it was a observed a tendency in the students to work individually by subdividing or compartmentalizing their work. This prevents a real interaction between students and makes it necessary to create the right conditions to promote formal (tutored sessions) and informal (workshop sessions self-organized by the students) interaction between all the members of the group.

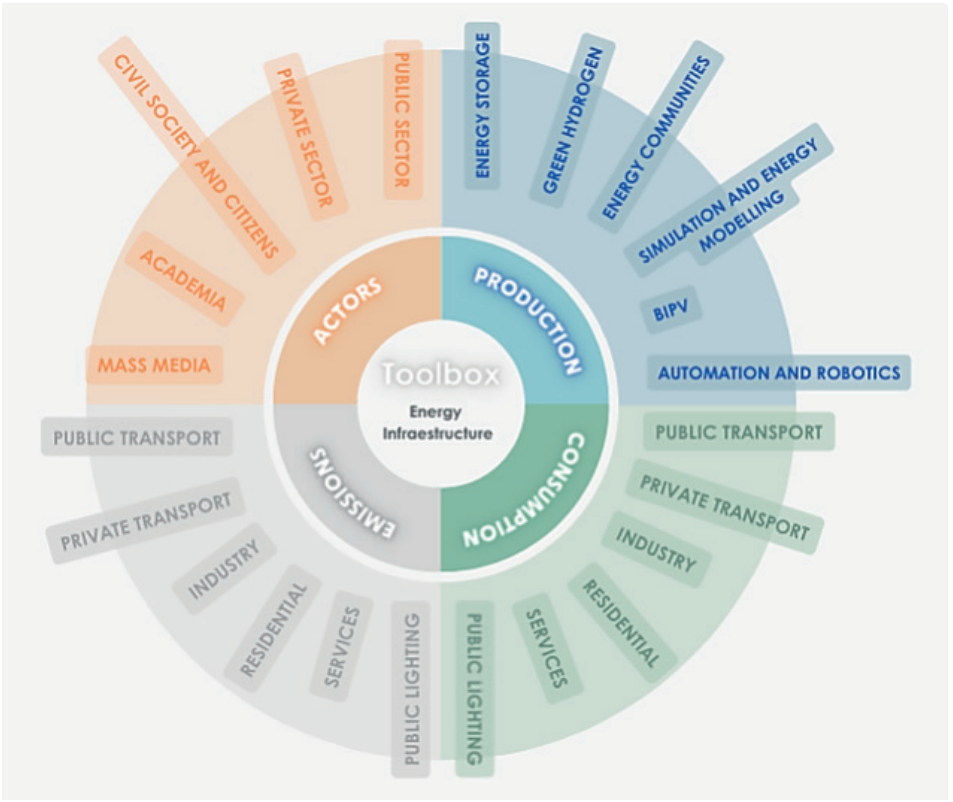


Figure 2.6.6. Generic Toolbox for an energy transition in Valencia Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

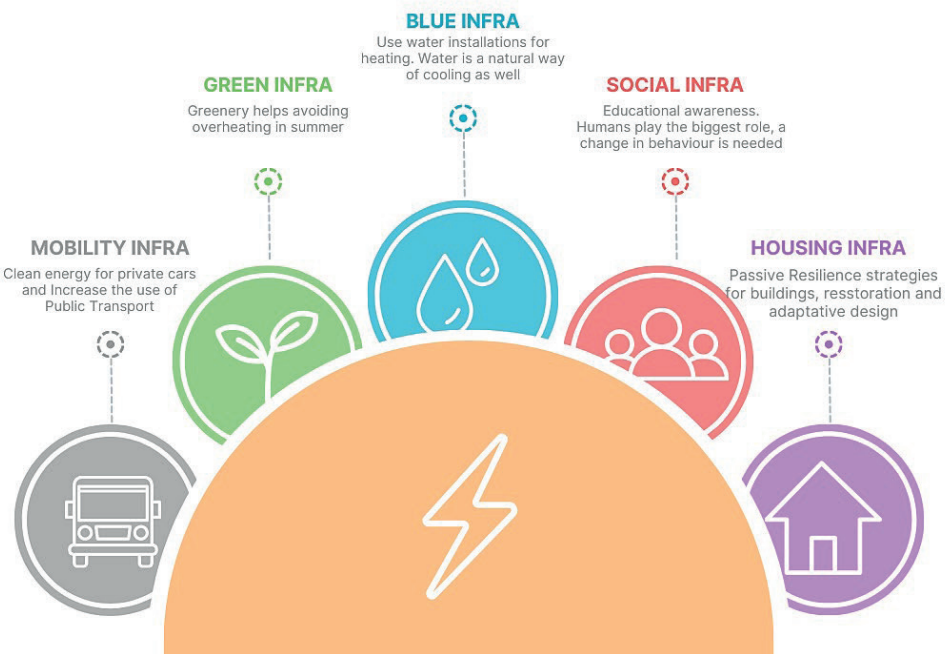


Figure 2.6.7. Preliminary identification of synergies with other urban infrastructure Valencia (source: Cubel, Hamdache, Archiles Zannouti, Kannampallil, & Del Río, 2023)

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