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ACTUAL ENERGY CONSUMPTION OF PARISIAN DWELLINGS

SUMMARY OF PART 1: SOCIAL HOUSING STOCK AND CLIMATE PLAN OPERATIONS

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Actual energy consumption of households in the Parisian social housing stock in 2022

88 kWh_{ef}/m^2

when heating is individual

153 kWh_{ef}/m^2

when heating is collective

(5 uses, in final energy, climate-adjusted)

kWh_{ef} (final energy) = net energy

By using an unprecedented statistical approach, Apur presents an overview of the actual energy consumption of over 76,000 social housing units in Paris and analyses the changes in consumption from before and after renovation work carried out on 9,000 social housing units which have been renovated under the Parisian Climate Plan.

The statistical approach to actual energy consumption in Parisian social housing developed in the study, provides complementary information to existing case studies carried out by social landlords. It also echoes studies made abroad on real energy consumption prior to and following energy enhancement work being carried out.

This study was carried out in partnership with the City of Paris and three social landlords: Paris Habitat, the Régie Immobilière de la Ville de Paris (RIVP) and Elogie-SIEMP, which between them manage a little over 70% of the social housing stock in Paris. While it is unprecedented on a city-wide scale, the work is also exploratory in its implementation. The tested methodology could pave the way for introducing a monitoring dashboard of actual energy consumption in the Parisian social housing and energy renovation operations, a diagnostic and prospective tool to help identify priority actions to be carried out to reduce consumption, greenhouse gas emissions and energy poverty.

Background information

In Paris, housing accounts for 46% of end use energy consumption excluding road traffic, 8%[1] of this is social housing. The renovation of buildings is a key issue in reducing energy consumption. In 2022, there were 1.1 million privately owned dwellings, spread among 50,000 residential condominiums and over 260,000 social housing units rented out by real estate groups managed by social landlords. These date from various periods and have different energy performance.

Since 2007, the City of Paris conforms its policies to its ecological planning document . The Climate Plan defines objectives, guidelines and plans of action to reduce greenhouse gas emissions, improve air quality and adapt the territory and its population to the consequences of climate change. To achieve these goals, the City of Paris assists social landlords in the rehabilitation of their properties via a subsidizing scheme. The objective for the City of Paris is to encourage reduction of energy consumption, as well as reduction of resources (promoting low carbon, circular economy), improving the comfort of tenants and developing renewable and recovery energy. Since 2016, with the initiatives "Éco-rénovons Paris" and "Éco-rénovons Paris +" (since 2022), private condominiums can also be assisted free of charge in their renovation projects and eventually benefit from funding for their implementation. A new Climate Plan for the 2024-2030 period will come into force this coming spring.

Since 2018, the SDES[2] has published local data on actual energy consumption at the address level, which opened up new opportunities for making territorial energy diagnoses and assessing the effects of renovation works. The thermal standards in force are based mainly on theoretical calculations made on actual energy consumption of buildings based on models. Actual consumption figures are collected from delivery points by energy suppliers. They reflect both the global scale factors (climatic variations and the cost of energy) and local scale factors (initial thermal performance of buildings and thermal performance following renovation work, heating characteristics and domestic water heating systems and their management, individual behavior of housing tenants, for example their sensitivity to the cost of energy and their appreciation of comfort).

The median consumption of ***130 kWh*** *per square m and per year in 2022, for housing in the sample, with significant consumption differences between dwellings.*

Method:

Energy consumption in kWh per square meter and per year given in the study correspond to the actual energy consumption read from energy meters. They are expressed as end user energy, distributed to the place of consumption. Consumption has been adjusted to correspond to 5 uses of energy defined in the National Thermal Regulations since 2005: heating, cooling, hot water, lighting and auxiliaries. Excluded from the analysis are: cooking energy and specific electricity uses, for example with household equipment. Consumptions are also adjusted to account for climatic variations to allow comparisons from one year to another.

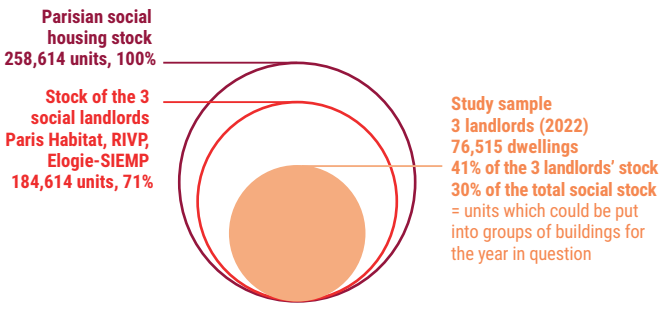
1 — Source : Rose, 2019.
2 — Data services and statistical studies of the Ministry of Ecological Transition and Territorial Cohesion: www.statistiques.developpement-durable.gouv.fr/
3 — Currently, half of the social dwellings financed in Paris correspond to agreements made for renovating existing buildings and are therefore not new buildings. The Parisian social stock is thus enhanced with housing built before 1915.

Actual energy consumption of Parisian social housing in 2022

A study sampel of more than 76,000 housing units

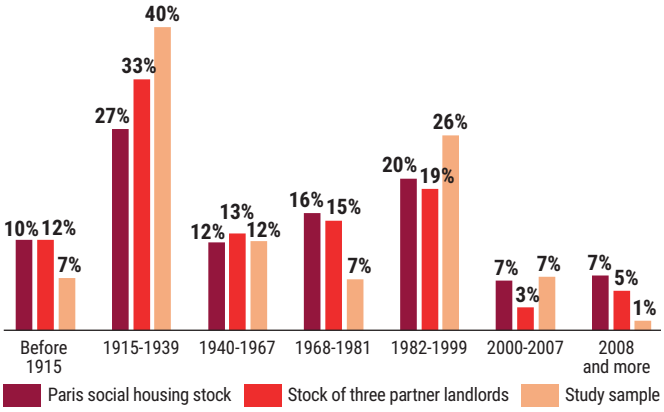
The analysis of actual energy consumption was carried out on a sample of 76,515 dwellings of the parisian social housing stock, representing 41% of the stock of three landlords partners of the study and 30% of the total social housing stock. It includes dwellings for which it was possible to reliably collect data on actual energy consumption in 2022 from the property groups as defined by the social landlords. This integration work was carried out on the parcel scale. The resulting dwelling sample structure differs from that of the partner landlord's stock or from the parisian social housing stock, due to the over-representation of dwellings with individual heating and those built between 1915 and 1939.

THE STUDY SAMPLE



Sources: Landlords, Apur, RPLS

NUMBER OF DWELLINGS PER PERIOD OF CONSTRUCTION

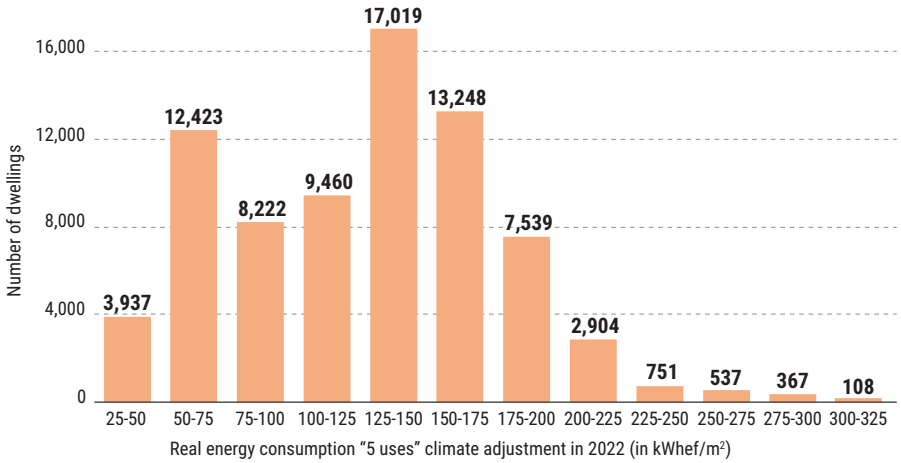


Sources: RPLS, Paris Habitat, RIVP, Elogie-Siemp, processing by Apur

A median energy consumption of 130 kWh per square m

The median consumption of dwellings in the sample reflects a quite energy efficient behavior of the social housing stock, which is regularly maintained by the landlords. However, the distribution of dwellings into consumption groups illustrates the extremely heterogeneous energy performance of dwellings.

ENERGY CONSUMPTION OF STUDY SAMPLE HOUSING, IN 2022
CONSUMPTION CATEGORIES



Sources: SPDE, RPLS, processing by Apur

This reflects the diversity of the Parisian social housing stock made up of buildings constructed during various periods. Specific periods correspond to buildings whose construction techniques follow the same logic dictated by the economic context, the availability of materials and the construction regulations in force at the time. The types of energy present in buildings also depend on their construction period and an understanding of the historical context in which building complexes were constructed can partly explain their energy consumption observed today[3].

The available data makes it possible to describe the energy consumption of dwellings by their heating system and by their construction period, whether they have undergone renovations or not.

The type of heating system has a decisive impact on consumption levels

Heating is the main source of household energy consumption. In Paris, it represents 60% of consumption[4]. The type of heating is a crucial factor in the level of energy consumed. This translates into important differences in energy consumption between housing with individual or collective heating systems and by the type of energy used.

Actual median consumption of dwellings in the sample equipped with individual heating is 88 kWh per square m and per year in 2022.

- **Dwellings with electric heating** represent 23% of the dwelling sample (16% of the dwellings of the housing stock three landlords). Their median actual final energy consumption is **65 kWh per square meter and per year** in 2022. Consumption levels appear to be low regardless of the building construction period. This can be explained by the ease of thermal regulation and by the very high cost of this type of energy which encourages energy efficiency (approximately 200 € per MWh). In some cases, low consumption implies heating is not used and the renovation of buildings can or could lead to a significant improvment of the comfort of its inhabitants.

- **Dwellings equipped with individual gas heating** represent 32% of the dwelling sample (21% of the dwellings of three landlord's housing stock). Housing with individual gas heating had a median consumption of **129 kWh per m² and per year** in 2022. Twice as much as dwellings equipped with electric heating, this leads households to spend less. With the tariff-cap put in place by the government in 2022, gas prices were approximately 90€ per MWh.

Actual median consumption of the sample's dwellings equipped with collective heating is 153 kWh per square m and per year in 2022.

- **Dwellings with collective gas heating** represent 24% of the housing sample (34% of the dwellings of three landlord's housing stock). Their median energy consumption is the highest in the housing sample: **174 kWh per m² and per annum.** It is high regardless of the building construction period. This implies that there is a significant potential for saving kWh if renovation work is done but also with more rigorous maintenance work on collective installations to be carried out.

- **Dwellings heated with urban heating** represent 20% of the housing sample (29% of the dwellings of three landlord's housing stock). Its median energy consumption is **140 kWh per m² and per annum.** The energy consumption of the older buildings was found to be higher than those built more recently. Similarly to buildings with collective gas heating, consumption levels suggest that there is a great potential for saving kWh if work is carried out but also with more stringent maintenance requirements of the collective systems.

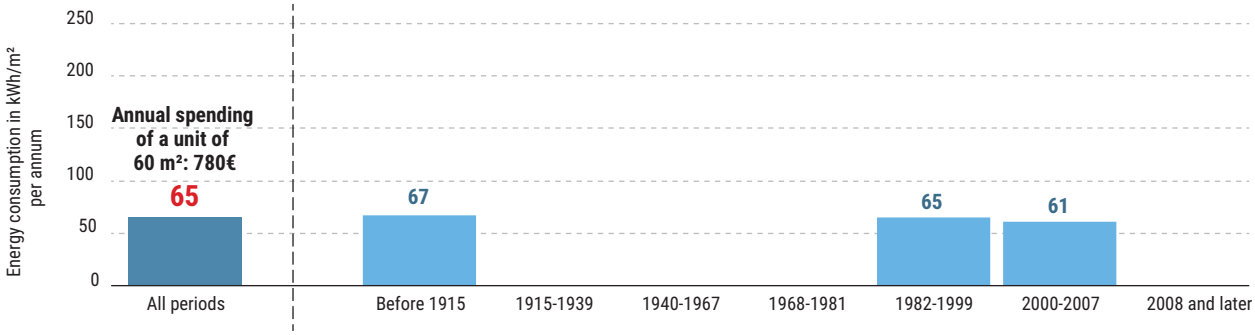
The observed differences can be explained by the construction period of buildings (and their initial energy performance and that after renovation work), the tenant's sensibility to energy prices, the characteristics of heating and domestic hot water systems (installation efficiency, internal distribution networks efficiency, regulating ease, strict application of heating periods and set temperatures when heating is collective). These various factors, which need to be contextualized for each operation, can be seen as many potential levers for further reducing energy consumption.

4 — Source: Energy balance of the City of Paris, 2019.

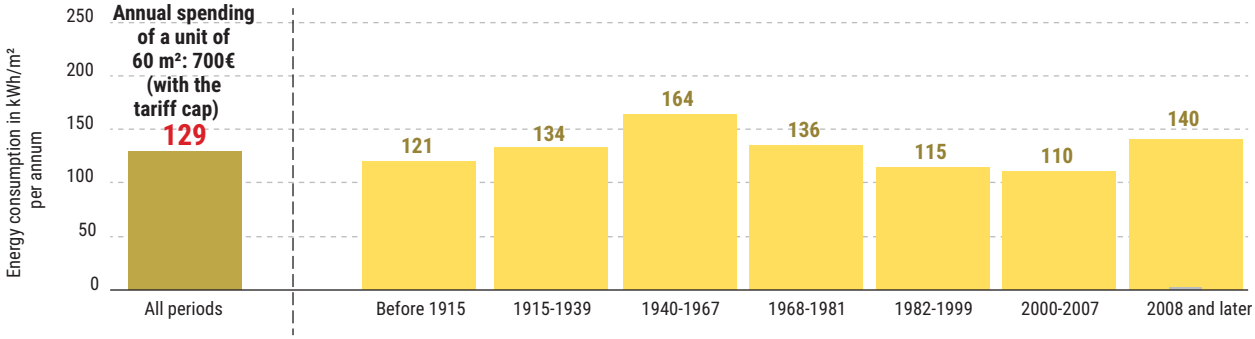
MEDIAN ENERGY CONSUMPTION* OF STUDY SAMPLE HOUSING, IN 2022

BY HEATING MODE AND PERIOD OF CONSTRUCTION

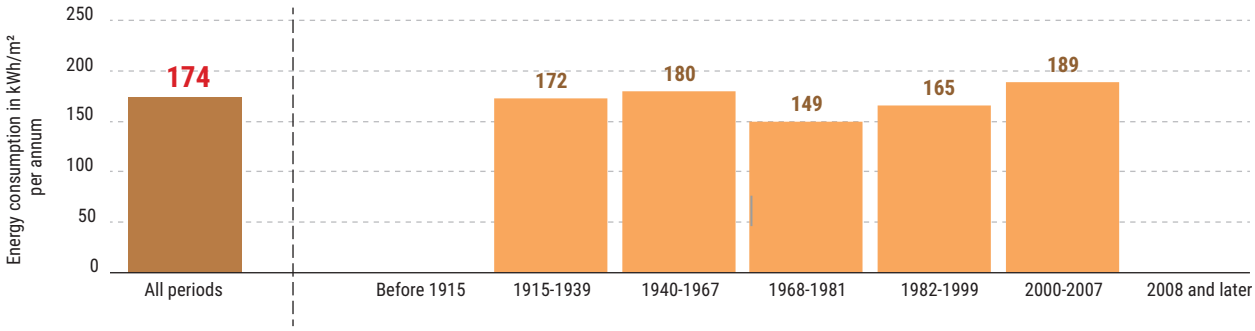
ELECTRIC HEATING (17,675 DWELLINGS - 23% OF SAMPLE HOUSING)



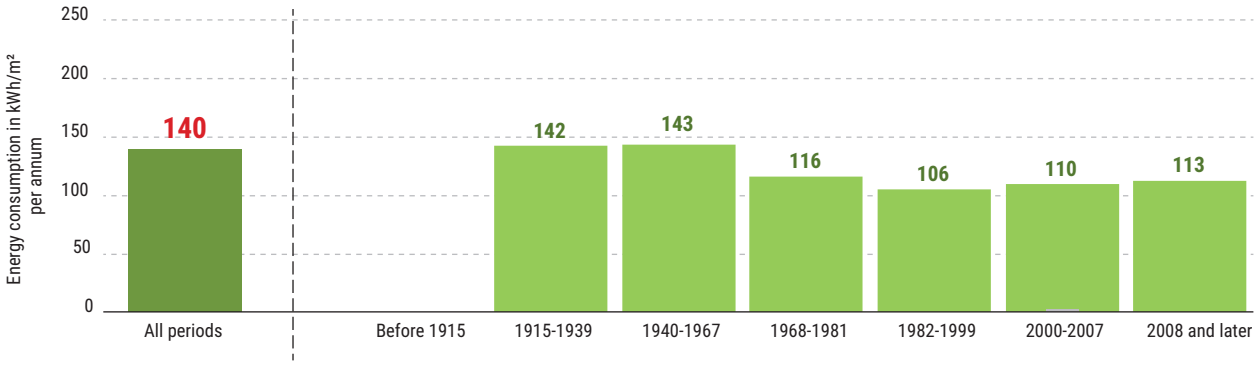
INDIVIDUAL GAS HEATING (24,554 DWELLINGS - 32% OF SAMPLE HOUSING)



COLLECTIVE GAS HEATING (18,678 DWELLINGS - 24% OF SAMPLE HOUSING)



DISTRICT HEATING - CPCU (15,608 DWELLINGS -20% OF SAMPLE HOUSING)



Reading note:
The median consumption of dwellings in the sample heated by the district heating system is 140 kWh per m² per annum, all construction periods considered. It is 143 kWh per m² per annum for housing built between 1940 and 1967.

Sources: SPDE, RPLS, Paris Habitat, RIVP, Elogie-Siemp, processing by Apur

(*): Real consumption of final energy "5 uses" climate adaptation

Feedback on energy consumption experiences before and after renovation work

The statistical analysis focuses on the first energy renovation operations carried out by social landlords, co-financed by the City of Paris within the framework of the Climate Air Energy Plan. These initial results are expected to be consolidated and analyzed in greater depth in the future, with larger samples of dwellings as renovation operations are finalized.

A study sample of more than 9,000 dwellings

The studied sample covers 51 renovation operations completed between 2012 and 2020, representing more than 9,000 dwellings. These renovation projects mainly concerned the most energy intensive property groups, particularly buildings constructed between 1940 and 1980 equipped with collective heating systems, commonly referred to as "thermal sieves". In these post-war buildings with no specific heritage characteristics, the addition of exterior thermal insulation, which largely determines the level of energy saving, has been carried out.

In the years to come, the number of energy renovation projects in the Paris social housing stock will increase. They will benefit from the changes in renovation methods carried out by landlords. These methods were drawn from experiments, and they will also involve a wider variety of buildings with fewer insulation options due to heritage or architectural constraints.

A reduction of actual energy consumption after renovation work

An increase in energy consumption resulting from the reduction was observed following the renovation work. This has been documented in a number of studies on the subject (particularly abroad). However, this bounce-back phenomenon has not been observed in any of the units renovated in Paris. Occasionally, it may be at the root of the moderate decreases in energy consumption observed in certain operations.

Results of renovation work carried out on dwellings within the sample have shown an average of 28% reduction in actual energy consumption. This saving ranges from -18% to -31% depending on the heating system used: -18% for operations in the sample heated by CPCU, -25% for operations in the sample with collective gas heating, -28% for operations in the sample with individual gas heating and -31% for operations in the sample with electric heating.

The amount of the reduction varies from one project to another, depending largely on each project's actual energy consumption before work, and the type of work carried out, especially the level of external insulation applied.

An avoided yearly energy consumption estimated at 2 236 kWh per housing unit

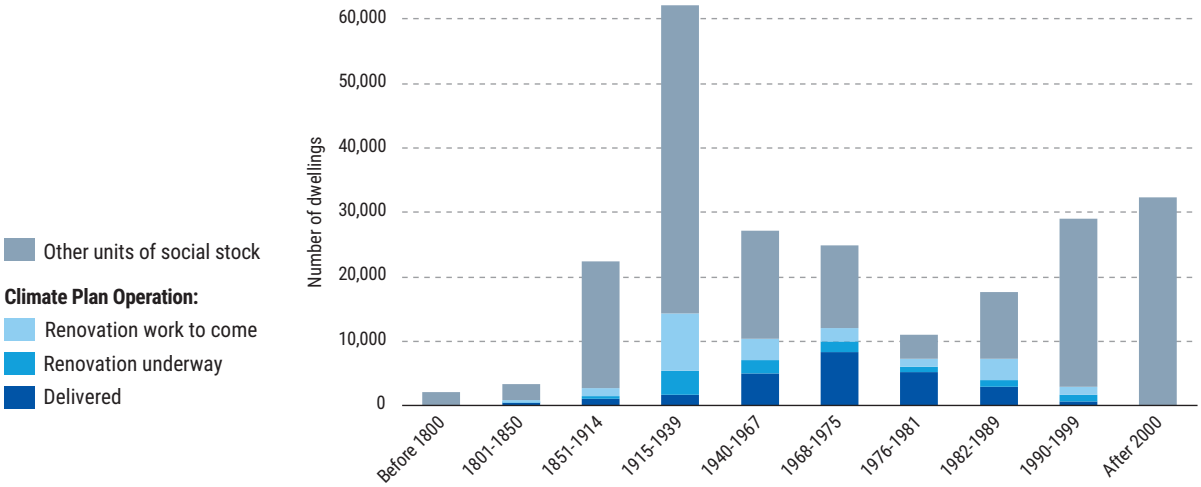
Thanks to the renovation work carried out, the average yearly energy consumption avoided per dwelling is estimated at 2,236 kWh, equating to a savings of 200 to 450€ per year and per household, depending on the heating energy used (2023 prices). This is a significant savings with respect to the average annual user end energy consumption of a household in France to cover the five regulatory uses of energy estimated at 11,000 kWh *(SDES 2021)*.

The annual energy savings in kWh appears to be much higher for property groups with an initially high energy consumption and a high "rate" of external thermal insulation once renovation work has been carried out. However, the disparity in results calls for further investigation and highlights the importance of a detailed understanding of operations and the renovations dig further into the analysis.

Method:

To assess the impact on energy consumption of renovation work on a building or group of buildings, it is necessary to compare consumption before and after renovation. If one considers the year n as the year when the renovation work was completed, consumption prior to the renovation taken into account in the study is the average consumption of the years n-1, n-2, and n-3 (if available). Consumption following renovation corresponds to the average consumption of all the years available starting from and including year n+2. Year n+1 is not included because it often corresponds to a system calibration phase. The years when consumption information is not given or seems abnormal are not taken into account. To qualify energy consumption before renovation work, the study benefits from actual energy consumption data which obtained by Apur from energy suppliers in the framework of previous studies.

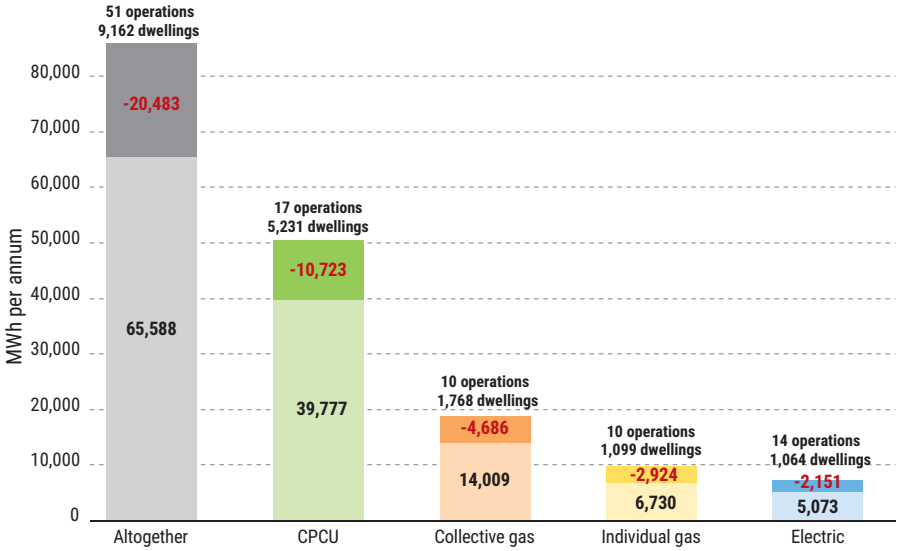
STATE OF PROGRESS OF CLIMATE PLAN OPERATIONS IN THE PARISIAN SOCIAL HOUSING STOCK BY PERIOD OF CONSTRUCTION



Sources: City of Paris DLH 2022, RPLS 2022, processing by Apur

*An average **28%** drop in consumption per operation after renovation work.*

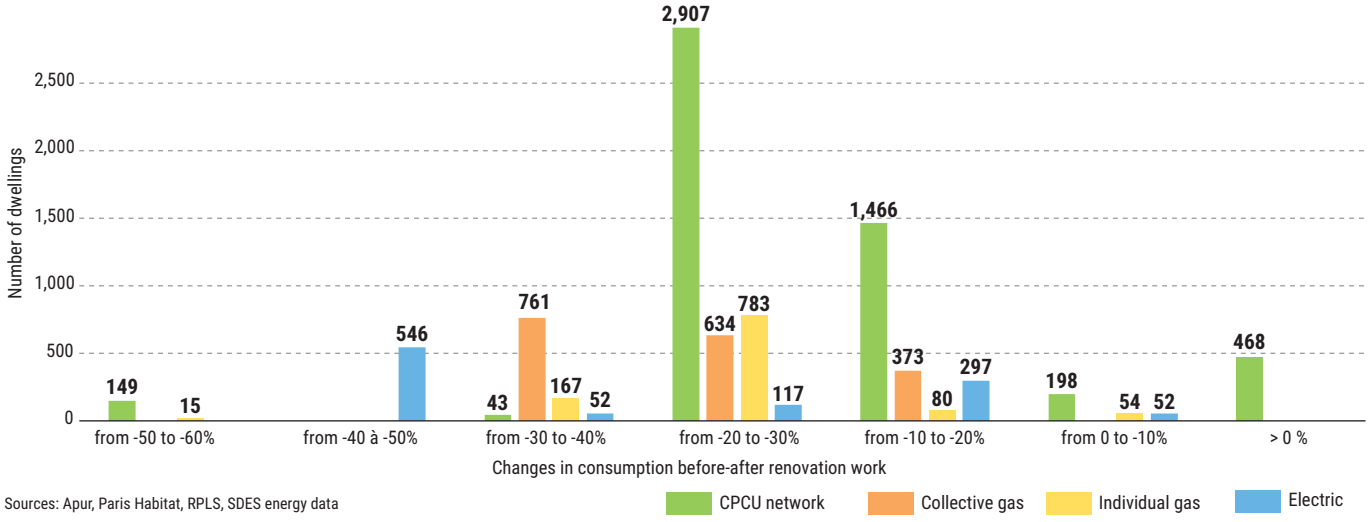
ENERGY SAVING OBSERVED AFTER RENOVATION WORK OF 9,162 SAMPLE DWELLINGS (MWH PER ANNUM)



Sources: Apur, Paris Habitat, RIVP, Elogie-Siemp, City of Paris (DLH), RPLS, SDES energy data

Reading note: Darker colour shades and marked in red, the annual energy consumption that has been economised after renovation work. Paler colour shades, average annual energy consumption of 5 uses after renovation work.

CHANGES (IN %) OF 5 USES ENERGY CONSUMPTION BEFORE AND AFTER RENOVATION WORK FOR 9,162 SAMPLE DWELLINGS



Sources: Apur, Paris Habitat, RPLS, SDES energy data

Changes in energy consumption before and after renovation work in the first Climate Plan operations. Results summary

All dwellings units in the renovation work sample

- **51** operations
- **9,162** housing units
- **-28%** average reduction in energy consumption (-30% when only considering 2022 as after renovation work)
- **-2,236 kWh** average energy saved per year and per housing unit
- **200 to 450 €** saved per year per household
- **-20,500 MWh** energy consumed each year

District heating (CPCU)

- **17** operations
- **5,231** housing units (57% of the renovation sample)
- **-18%** average reduction in energy consumption (-25% considering only 2022 as after renovation work)
- **-2,050 kWh** average energy saved per year per household
- **-10,723 MWh** energy consumed each year

Collective gas heating

- **10** operations
- **1,768** housing units (19% of the renovation sample)
- **-25%** average reduction in energy consumption (-24% considering only 2022 as after renovation work)
- **-2,650 kWh** average energy saved per year per household
- **-4,686 MWh** energy consumed each year

Individual gas heating

- **10** operations
- **1,099** housing units (12% of the renovation sample)
- **-28%** average reduction in energy consumption (-35% considering only 2022 as after renovation work)
- **-2,661 kWh** average energy saved per year per household
- **-2,924 MWh** energy consumed each year

Electric heating

- **14** operations
- **1,064** housing units (12% of the renovation sample)
- **-31%** average reduction in energy consumption (-34% considering only 2022 as after renovation work)
- **-2,021 kWh** average energy saved per year per household
- **-2,151 MWh** energy consumed each year.

- **These initial results, to be shared and consolidated, raise questions on the levers and priorities for action to renovate the social housing stock.** Among the main ideas that emerged from the discussions with the study's partners, we can cite:
- Setup of regular monitoring of the actual energy consumption in the social housing stock.
- Document more acurately the risks of energetic poverty among tenants of electrically heated dwellings and awareness of how dwellings are used, in winter and in summer.

Following its work carried out on the social housing stock, Apur plans to extend the observation of actual energy consumption to the private housing stock and tertiary buildings in Paris.

This note summarises the results of the study of the same name:
www.apur.org/fr/nos-travaux/consommations-reelles-energie-logements-parisiens-volet-1-parc-social-operations-plan-climat

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