French higher domestic specific electricity consumption Compared to Germany: Explanatory Factors Assessment

Study carried out by

SOWATT and Enerdata

For ADEME

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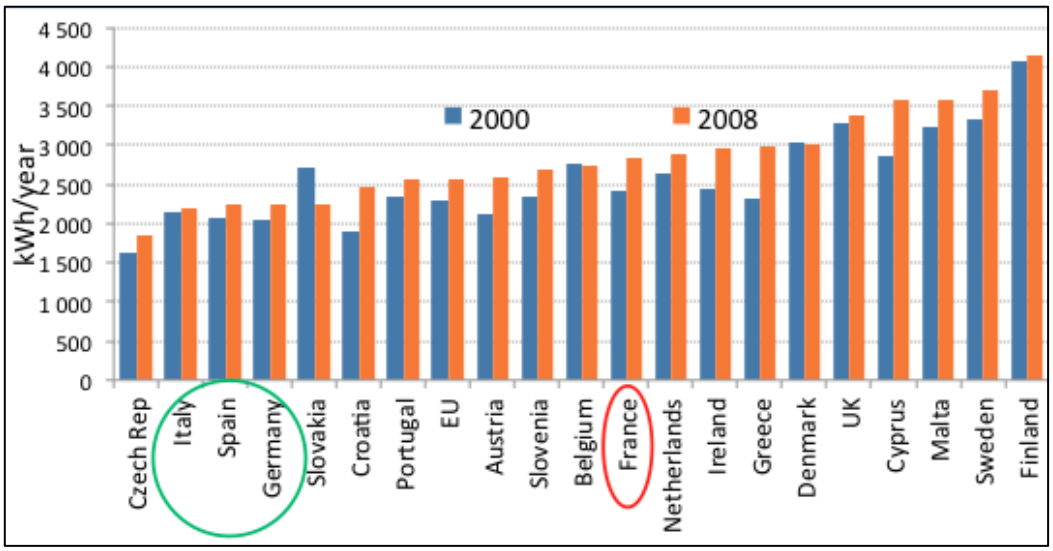
1. Context and goals

ADEME monitors energy performance in the residential market according to detailed technical and economical energy efficiency indicators. The ODYSEE international benchmark reviews show that France is not performing as well as Germany regarding specific electricity consumption[1]. Households' specific electricity consumption was 26% higher than in Germany in 2008[2] (Graph 1). Italy and Spain's good ranking can mainly be explained by the lower income and consequent lower equipment rate, compared to France[3].

Graph 1: Household electricity consumption for domestic appliances and lighting



Source: ODYSSEE

This report aims at identifying and quantifying the main factors influencing specific electricity consumption differences observed between France and Germany. It further reviews the potential change leverages through targeted policies in both countries, and it proposes policy measures to reduce this difference.

2. Explanatory factors analysis

The analysis focuses on large domestic appliances, which present the largest available benchmarking data and consume more than 40% of specific electricity, on lighting (which accounts for 15% of specific electricity), and on the main consumer electronics (TV, computers) (Graph 2).

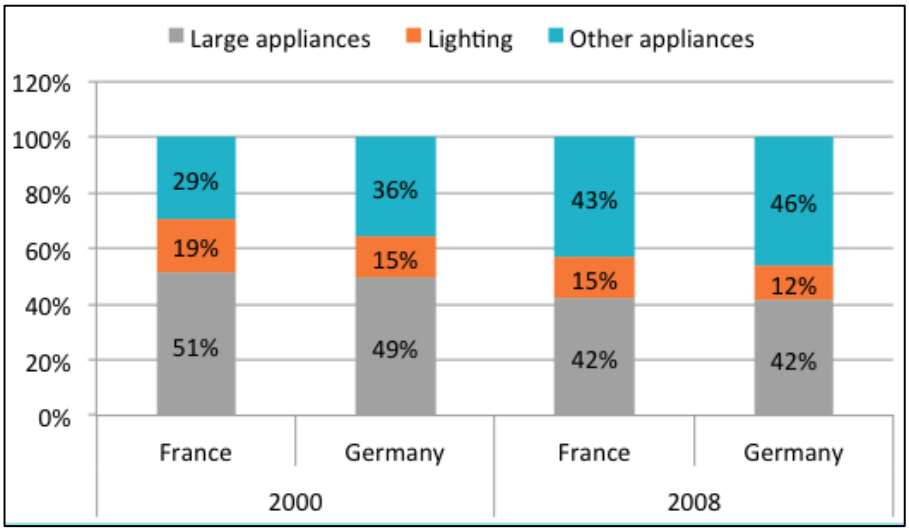
Several factors have been taken into account:

- Equipment rate in large domestic appliances, home entertainment electronics (TVs, PCs) and lighting;
- Appliances' size, especially cold appliances and TVs;
- Efficiency level according to the Energy Label (A, A+, etc.);

[1] Specific Electricity includes all non-thermal use, i.e. small and large domestic appliances, consumer electronics and lighting.
[2] 2008 is the preferred reference due to 2009's particularity with the economic crisis.
[3] In addition, most Italian households benefit from regressive electricity tariffs, and a 3kW subscription contract, which limits consumption level.

- Equipment features and functionalities impacting consumption (upright-freezers versus chest freezers; frost-free and built-in cold appliances);
- Equipment price according to respective energy efficiency;
- Consumer attitude (frequency of use and preferred temperature for washing appliances; duration of use of TVs and lighting equipment);
- Electricity tariffs.

Graph 2: Breakdown of the specific electricity consumption in % (large appliances, lighting, other appliances)



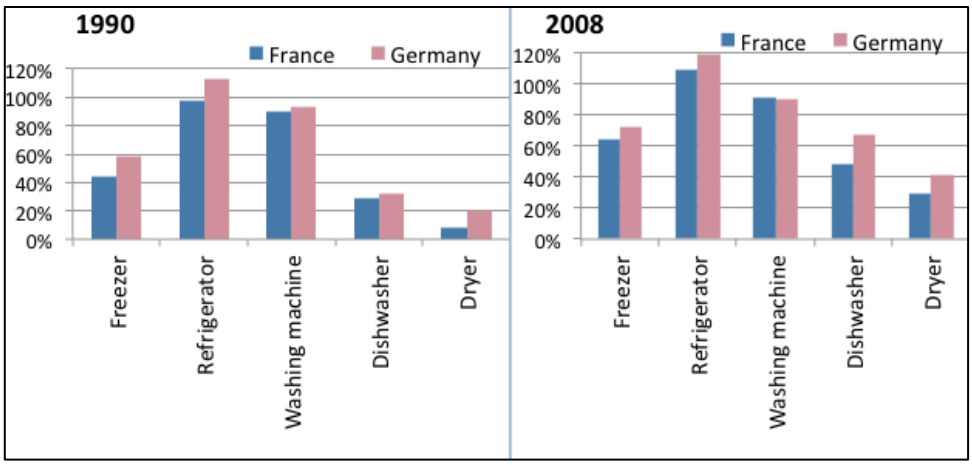
Source: ODYSSEE

2.1. Large domestic appliances

- **Equipment rates and sizes**

Although both countries equipment rates levels are close, Germany's are higher (Graph 3). But France is gradually reaching similar rates, in particular for freezers, refrigerators, and washing machines.

Graph 3: Equipment rate in France and in Germany



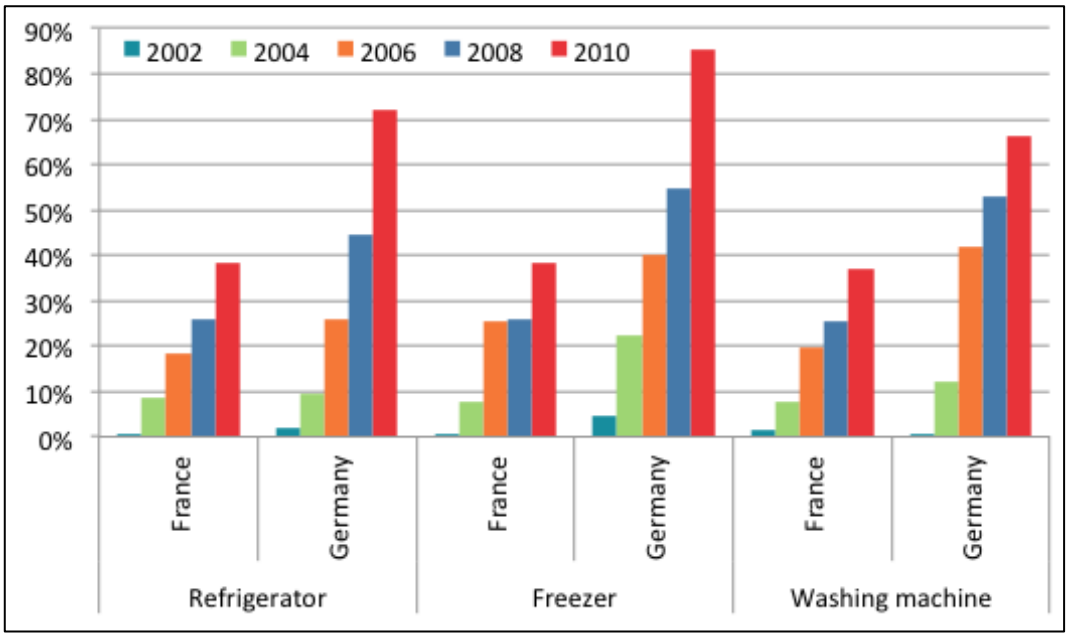
Sources: ODYSSEE, INSEE, SOFRES

Refrigerators and freezers sold in France are larger than the ones sold in Germany (+30% and +23% larger respectively). The size difference for washing machines and dishwasher is hardly significant.

- **Equipment efficiency**

Very energy efficient appliances[4] penetration is higher into the German market (Graph 4). In 2010, A+ rated washing machines' market share is thus 10 points higher in Germany, 34 points for A+ and A++ refrigerators, 47 points for A+ and A++ freezers.

Graph 4: Penetration of A+ and A++ labels by type of appliances (% of sales)



Source: GfK

- **Equipment types and functionalities**

Efficient cold appliances' (table-top, 1 and 2-doors[5]) sales are higher in Germany compared with France. French consumers buy twice the number of frost-free refrigerators (18% of French sales in 2008, versus 9% in Germany). This system is more energy consuming and lessens France's performance. On the contrary, the German market share of built-in refrigerators, which are less energy-efficient, was 45% in 2008 vs. only 13% in France.

The market share of upright-freezers', which are more energy consuming than the chest type, is 30 % larger in Germany than in France. Frost-free freezers' market share is also higher in Germany (23% vs. 10%). Freezers sold in Germany are overall more energy consuming than the appliances sold in France.

Front-loading washing machines' sales are higher in Germany (90% vs. 59% in France), but their share has been quickly increasing in France (from 25% in 2000 to 59% in 2008). Top-

[4] Most energy-efficient appliances are at least rated A+ on the energy label. In 2010, the cold appliances' energy label ranges from C to A++; the washing machines' energy label from G to A (but manufacturers are allowed to signal "A+" performance); dish-washers' label ranges from G to A.
[5] "Table-Top" models are 1-door refrigerators, with a 90 cm maximum height.

loading washers are usually less efficient than the front-loading type[6]. Ventilation dryers' market share is twice as high in France (42% vs. 19% in Germany). Condenser dryers are more energy-efficient when equipped with a heat pump[7].

While refrigerators, washing machines and dryers bought in France are overall more energy consuming than in Germany, German consumers tend to buy freezers with more high energy consuming functionalities than the products favoured by French consumers.

- Appliances' pricing

Most energy-efficient cold appliances are more expensive in France than in Germany. The price difference can reach up to 20% for class A+ or A freezers and 13% for A+ refrigerators. The price difference between an A and an « A+/A++ » washing machine is higher in France than in Germany (39% vs. 23%).

Sales prices according to the energy label are partly determined according to market shares. High efficient appliances (A++ and A+) market share is notably lower in France compared to Germany. The price difference can be explained by this restricted potential market, and lack of trust from the manufacturers' part in the French consumer "green" awareness, which leads them to market less energy-efficient models.

- Attitudes

If Germans use higher temperature[8] water to wash their laundry and dishes than French households, they will easily use economic cycles. In addition, German households will fully load their washing appliances, reducing the number of cycles and the electricity consumption (Source: Remodece[9]).

French households declare cleaning the refrigerator's evaporator pan more often (25% monthly vs. 5% in Germany; and 38% once a year in France vs. 15% in Germany). French consumers defrost their refrigerators and freezers more often. In Germany, over 20% of respondents declare having set the thermostat on the lowest temperature, vs. only 3% in France.

Although it is impossible to quantify each attitude's impact in terms of consumption, they tend to partially compensate each other, and hardly play a part in the observed consumption discrepancy.

2.2. Lighting

Lighting electricity consumption is notably higher (+49%) in France than in Germany in 2008. This consumption gap does not lie in the number of lights, because it is identical in both countries: 25 lights on average per household.

[6] Top-loading washing machines lower efficiency level can be explained by their relative small market share, and by the fact that manufacturers choose to invest in the front-loading range optimisation.

[7] This was not the case in 2008, when most condenser dryers were classic models (without heat pump).

[8] In France 29% of households wash their laundry at 65°C vs. 50% in Germany, 51% at 50°C vs. 40% in Germany. 44% in Germany wash their dishes at 65°C vs. 21% in France

[9] This study involved a 500 people panel in the two countries. Although it was led in 2006, it helps understand consumers' attitudes differences between the two countries "*Residential monitoring to decrease energy use and carbon emissions in Europe"*; EIE project, 2007.

In contrast, the German households have installed twice as many compact fluorescent lamps as in France (6,5 /house in Germany vs. 3 in France). Compact fluorescent lamps' penetration can explain part of the difference in consumption. According to the REMODECE report, the noted differences in consumers' attitude towards lighting offset each other.

2.3. Consumer electronics and other small appliances

The average number of TVs per household is similar, with around 1,5 TV/household in 2008 in both countries. TV size and duration of use are close. As a result, there is no significant difference in TV energy-efficiency.

The equipment rate in computers is slightly higher in Germany. Screens sold in Germany will be notably larger than the models sold in France: 21" vs. 20" in 2010.

Laptops spreading encouraged multi equipment in PC's. The average number of PCs per household has grown from 56% in 2003 to 103% in 2010 in France; and from 82% to 110% in Germany. It has been paired with the Internet development, resulting in a higher penetration rate in Germany than in France (82% et 75% en 2010).

Set-top-box systems have also rapidly grown in the last ten years, again spreading faster in Germany than in France.

With a higher equipment rate in PCs, electricity consumption is also higher in Germany.

In 2010, these 3 appliance-types' consumption accounted for 200 kWh in France and 250 kWh in Germany.

2.4. Electricity tariffs

Residential electricity tariff in France is currently about half of the German tariff. Half of the difference can be explained by cost differences (without VAT) (difference of nearly 60%), the other half by taxes variations. VAT weighs equally in both countries (around 15%). Other taxes are much higher in Germany, accounting for 27% of electricity total cost (of which an 8% eco-tax since 2000), versus 10% in France.

In order to assess these cost differences, we attempted to measure households' sensitivity to electricity costs variation, through an econometric analysis. Unfortunately, the price elasticity is very difficult to gauge for the 1990-2010 period, and results lack statistic consistency.

3. Adjusted efficiency indicators

We designed adjusted specific consumption indicators, correcting the observed discrepancies' respective impact between countries, in order to quantify each factor's exact impact.

Adjustments have been made on the following differences between France and Germany: equipment rate and size (for large domestic appliances), energy labels penetration (for large domestic appliances and lighting), and appliances' features and frequency of use (for

washing machines). This allowed for simulations of fictive Germany's specific electricity consumption adjusted to French conditions[10].

Adjusting the German unit consumption to the French equipment rate enlarged the 26% initial gap between the two countries to 33,5% (Table 2).

Table 1: Adjusted Germany's electricity consumption to France's equipment rate (2008)

kWh/household/year	Large domestic	Lighting	Consumer electronics	Small electric appl.	Other	Total
Germany	929	278	569	394	67	2,237
Germany, adjusted to equipment rate in France	**820**	278	**507**	**445**	67	**2,117**
France	1,195	414	507	425	284	2,825

Source: France, Germany: ODYSSEE; adjustment: calculation Enerdata

Highly efficient appliances penetration being stronger in Germany, adjusting the German unit consumption to the energy labels' dissemination in France reduces the spread between the two countries, from 26% to 15% (Table 2): in conclusion, 40% of the spread could be explained by the difference in penetration of highly efficient appliances.

Table 2: Adjusted Germany's consumption to France's energy label penetration rate (2008)

kWh/household/year	Large domestic	Lighting	Consumer electronics	Small electric appl.	Other	Total
Germany	929	278	569	394	67	2,237
Germany, adjusted to equipment rate in France	**1,002**	**372**	569	394	67	2,404
France	1,195	414	507	425	284	2,825

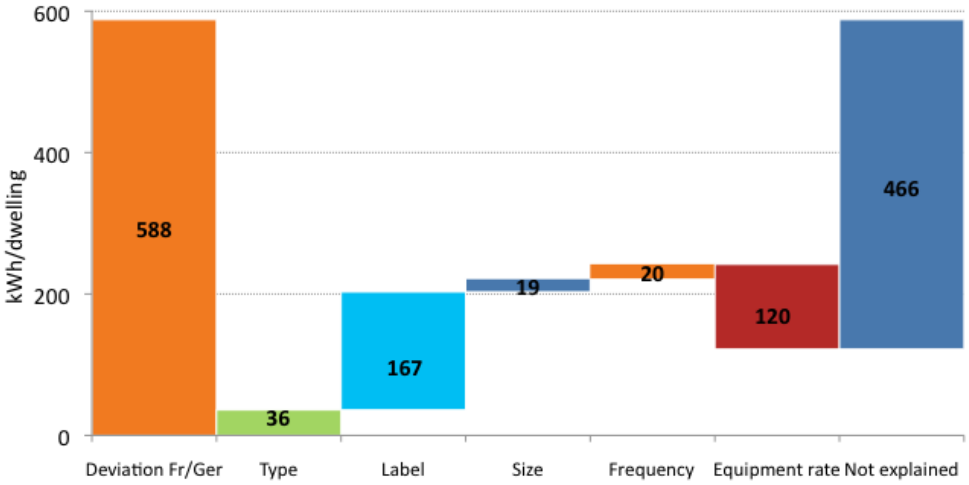
Source: France, Germany: ODYSSEE; adjustment: calculation Enerdata

The adjustment of observed consumption in Germany to the average size of appliances sold in France only reduces slightly the spread from 26% to 25%. Which means that size of large domestic, and lighting equipment play a minor role. Technical features and functionalities have also a marginal impact as the adjustment calculation shows that the difference reduction is of only 2 points. And finally, when adjusted to frequency of use in France, the German specific consumption growth is also marginal (20 kWh).

The respective weight of the above five adjustments differ, as only two main adjustments significantly impact electricity consumption: equipment rate and energy labels penetration. Unfortunately, the two partly offset each other, which cannot explain the total performance gap between France and Germany. The calculation shows that only 21% of the observed 588 kWh difference can be explained by the factors and thus by their adjustments (Graph 5). The remaining difference could lie in the statistical breakdown between thermal and specific electricity use, as the difference of consumption not explained is larger in Germany than in France.

[10] For example, with the equipment rate adjustment, we apply the observed rate in France to Germany to each type of appliance. The Germany's fictive specific consumption is thus obtained applying the French equipment rate, all else being equal.

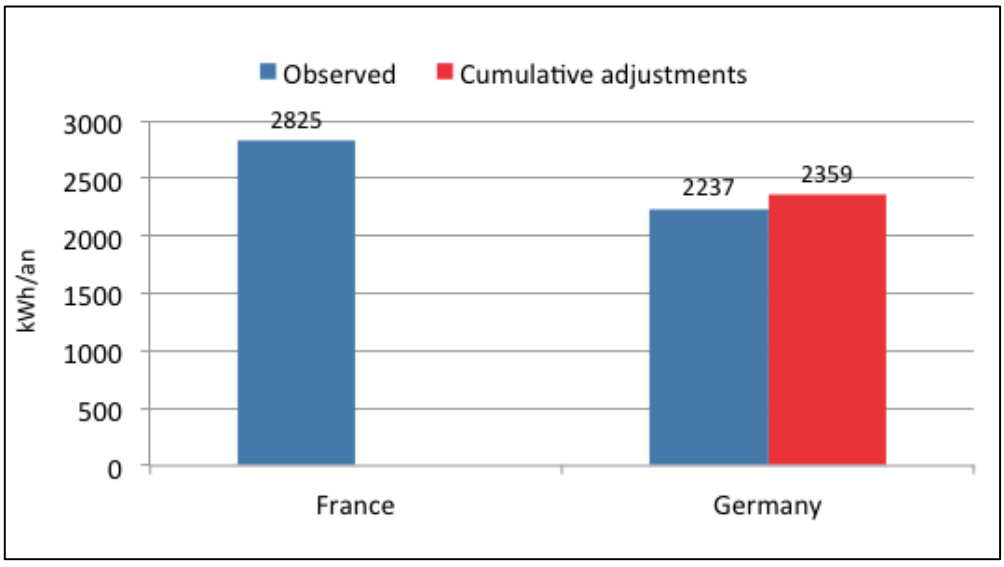
Graph 5: Breakdown of adjustments on the observed electricity consumption difference



Source: calculation Enerdata

When combining the five adjustments, France's specific consumption remains significantly higher: 20% vs. 26% (Graph 6).

Graph 6: Germany's unitary consumption adjusted to France (2008)



Source: calculation Enerdata

4. Identifying qualitative factors

Qualitative factors could also explain the difference of consumption. The following are based on the factors influencing the penetration of energy efficient electrical appliances into national markets in Europe identified by a survey led for the British government[11]. They are grouped

[11] Study on the factors influencing the penetration of energy efficient electrical appliances into national markets in Europe, Attali / Bush, DEFRA – MTP, 2009

under four types: factors relating to electricity prices and country structure, factors relating to the appliance market, factors relating to consumers' attitude, and factors relating to policy issues.

4.1.1. Country structure

Countries can be more or less well organised to promote energy savings - especially electric efficiency. Their organisation level can be assessed according to the presence of institutions dedicated to develop and to disseminate energy efficiency messages, their history and anchorage in the country's administrative structure, the support they receive, their local presence (as demand-side management requires to reach millions of users individually), their ability to launch regulatory control and incentive measures, and their ability to dialogue with manufacturers without being influenced by them, etc.
In addition, the European countries have set up different structures to enforce European regulations, including market assessment and control: do they have the capacities to test appliances and sanction if necessary?
Finally, public buyers' commitment to prefer efficient appliances can also greatly impact performance, as they act as opinion leaders.
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4.1.2. Appliance market structure

The market for electrical appliances is composed of a chain of actors where each link has a specific role to play, but where actors can vary in their positioning. For example:

- Manufacturers view national markets' consumers more or less ready to pay for energy efficiency; the ranges proposed to retailers will reflect their perception (while consumers obviously cannot buy products that are not available on the market);
- Wholesales (for franchised shops) negotiate margins more or less aggressively;
- The retailing market is more or less concentrated, with varying degrees of freedom to build their range in shops, and of independence from manufacturers;
- Retailers either favour quality products sales which benefit from larger margins or on the contrary will promote lesser quality products, with a lower margin but which are sold in massive quantity;
- Online sales can interfere with these scenario and extend the offer to a wider range of appliances;
- In shops or online, retailers will either choose to provide information of quality on their products, or minimal information;
- Business ties between manufacturers and retailers are multi-layered, which makes pricing analysis complex, as for example, discounts can be offered on specific refrigerators if the washing machines sold under the same brand reach the agreed quota;
- Prices are generally too low to incite buying efficient appliances;
- Efficient appliances' prices are so high that they remain niche products (the energy label's revision makes it particularly difficult to pay at least 200 € more for an A+++ than for an A appliance, as A might be perceived as excellent, and each "+" apparent value would seem marginal).

4.1.3. Consumers attitude

Products sold in Europe vary, and so do consumers: cultural factors have to be taken into account as they can influence consumers' perception of:

- Environmental issues: when consumers are aware of the environmental degradation, when they know the energy label, when they can connect appliances, electricity and climate together, then the sales speech relating to environmental issues is more

effective and weigh on their decision (while it may not represent the decisive factor, it stills contributes to it).

- The energy label scheme: if the label is well known, and has been promoted through on-going campaigns targeting consumers and trainings have been provided to retailers, it will tend to become an important buying decision criterion.
- Brands: “quality” brands generally market a larger range of efficient appliances, and in countries where customers declare paying attention to brands, efficient appliances’ market share is also rather more important.
- Trends: trends can be more or less in favour of energy savings issues – in one case, sales will promote the modernity and gadgets of American refrigerators, which consume a maximum of electricity; in the other, they will promote silent high-end built-in appliances (which are very often also highly efficient) to be fitted in open-plan kitchens. Manufacturers develop large volume washing machines, which will achieve a better rating on the energy label, and promote their “flexibility of use”, thus creating a new need (whereas the average load remains approximately 4kg, whatever model is used);
- Appliance price: price perception is not a sufficient explanation for the national market shares’ breakdowns, but it plays a major role as in countries sensitive to branding, consumers will benchmark high-end products’ prices, while in other countries priority is given to the lowest price of acquisition, consumers are reluctant to spend more, and even financial advantage on the product’s lifetime are not incentive.

4.1.4. Policy issues

Most European countries have tried to pull their market towards more efficient appliances, through national or regional measures. Without going into details of the main implemented policy instruments, national European markets, have been influenced - on the short and/or long term- by:

- Informative tools targeting the end-consumer, such as labels to distinguish specific appliances. With these tools, manufacturers and retailers are legally bound to publish measures and data from harmonised processes. Transparency is infused in the market. Before the introduction of the Energy label, energy efficiency information was not available to consumers.
- This obligation corollary: in order to be seen as reliable, the manufacturers’ declaration must be tested and controlled, with sanctions if necessary, which is not always the case everywhere in Europe. Many consumers NGOs and some manufacturers are addressing this issue.
- The national authorities’ understanding of the specificities of the market: some countries closely follow-up the market and the products, and look to adapt policy instruments accordingly (with more or less success); certain countries are able to benchmark on a European level, while others lack the basic data to take action.
- The national authorities’ ability to negotiate, and their flexibility: institutions’ response and time frameworks can become incompatible with the market’s deadlines.

4.2. Analysis of respective qualitative factors and policy instruments

The analysis of Germany’s and France’s respective policies and instruments show considerable similarity, with the following notable exceptions:

- When the right conditions are met, electricity tariffs are higher in Germany, and the long term benefits from buying energy efficient appliances are more obvious: one invests a bit more when buying, but will durably save on the electricity bill for the appliance lifetime duration.
- When the financial advantage is not convincing enough, the better environmental performance is taken into account: Germany has been implementing awareness programmes about environmental issues for longer than France, with more continuity.

- Manufacturers present in Germany are very proactive and push high-end high-efficiency appliances on the market.

Germany further has two other advantages over France, which may be difficult to quantify, but which most certainly influence consumers positively regarding electricity consumption: German consumers are more sensitive to environmental issues; they value brands they perceive as “quality” brands, and they ponder their needs before buying domestic appliances. This is the result of the awareness programmes.
German households also benefit from numerous demand-side management programmes run locally by Länders, cities and over 1,000 electricity providers, some of which are managed by local authorities and have been involved in DSM for decades.

4.3. Policy recommendations

Several policy measures have proven to effectively impact specific electricity consumption. Implementation can be innovative, even if the instruments are well known, the challenge rather lies in the continuity with which the action will be implemented, and the set level of ambition.

First of all, regular and on-going information and awareness campaigns must target the general public. Countries like Denmark or Germany, where children have been continuously exposed to awareness campaigns since the 70’s and the first oil crisis, present better results. Regulatory instruments must be accompanied by recommendations on buying and using ever evolving products. Information programmes should aim at ambitious objectives, even if it means going against the market actors’ habits, including manufacturers’ and retailers’. Many sociologists reported the need to differentiate consumers, to get them on-board, to win their trust, and to explain issues in a way that they can personally relate to, and to help them globally change their consuming attitude.

Very strong and structuring measures are decided and implemented on the European level (Energy Label and Eco Design Directives). Member States can influence decision with technical expertise, and defend more ambitious positions and tightened agendas that those proposed by the European Commission. Such audacious positions are crucial, as experts agree that minimum performance thresholds and energy labels are the most effective tools available. In particular, the design of minimum energy performance standards or energy labels should encounter for a maximum absolute energy consumption level whatever the size of the model which would result in limiting the size of appliances (c.f. "progressive standard" for TVs in the USA).

In order to strengthen the European Directives, Member States have the responsibility to control their enforcement. Such controls are actually rarely done, in France or in Germany, although they would allow recognition for virtuous manufacturers playing along and incite them to further invest in energy efficiency (without fearing loosing ground to uncontrolled and un-sanctioned competitors providing false declarations). Tests and compliance are of interest to consumers and journalists, as shown by the ATLETE[12] European project: the tests results of several refrigerators models unveiled a 57% rate of problematic declarations.
According to the local context and available resources, two testing programmes can be implemented:

- Official testing, on a regular basis, on a large volume of appliances, led by the market surveillance authority in charge of the enforcement of Eco-design and Energy label Directives, with specific related sets of sanctions;

[12] http://www.atlete.eu/

- One-shot tests campaigns, on a limited scale, well organised with a communication plan targeting manufacturers, retailers and consumers.

Changing the design of electricity tariffs is another powerful instrument, implying detailed negotiations, but without contribution from the State's budget. Such actions in Italy, the United-Kingdom and California have shown that it is possible to change the structure so that electricity actors (generators, distributors, suppliers) are not encouraged to ever sell more kWh. One can quote progressive tariffs, which will incite users to invest in energy-efficient appliances, the allocation of a share of the electricity price to DSM programmes, or the good coordination of rules and respective roles of energy producers, retailers and suppliers.

Financial incentives such as rebate programmes are expensive but their results in terms of market shares can be rapidly measured. In addition, they push manufacturers and retailers towards more customer-tailored information and to invest in R&D. They are however difficult to calibrate, due to the market's speed of change; they are effective in Switzerland, where rebates exclusively go to the most efficient appliances, which are re-assessed and listed at least twice a year to adapt to the market evolution pace (the lists also serve as a safe guideline for public buyers). They also allow achieving the full energy saving potential as they avoid supporting "not so bad" appliances, but which would anyway waste additional 50 kWh annually, during an average 15-years lifetime.

Bonuses and maluses could be combined to balance the operation, but the relatively low and ever-changing prices together with the retailers' range policies (all manufacturers market both efficient and lower-end products) make this approach more complex. It seems difficult to add the objective of fighting against fuel poverty to such a rebate or a bonus/malus programme, because energy efficient appliances are still too expensive for people suffering from fuel poverty. It is advised to implement separate measures for each objective, with for example, a market transformation rebate programme on one hand, and working on fuel poverty with bulk buying, retailers and social housing actors, on the other hand.

Finally, new technologies allow for more fine-tuning and personalised tools: in Germany, "Smart meters" could be used to give feedback to consumers and help them manage their electricity consumption, beyond the support these tools can provide regarding the power grid's peak management.

5. Conclusions

Specific electricity consumption of households in Germany was 26% lower than in France in 2008, with comparable revenue levels. The aim of this report was to determine which quantitative and qualitative factors could explain the 600 kWh consumption gap.

On the quantitative front, 2 main factors partly explain the higher consumption in France:

- Large domestic appliances are larger in France than in Germany: over 20% larger refrigerators and freezers, which are both the most common and the most energy consuming appliances in households.
- A better penetration of efficient appliances[13] in Germany (washing machines, cold appliances, and lighting), which can mostly be explained by the lower price of energy efficient products in Germany.

At the opposite, factors should compensate the difference and raise the consumption in Germany:

[13] i.e. A, A+ or A++ on the energy label following the appliance.

- The refrigerators, washing machines and dryers sold in Germany usually have more energy-consuming features and functionalities (frost-free refrigeration, built-in models, condensing driers, etc.) than the appliances types sold in France.
- The equipment rate of large domestic appliances in France is slightly lower in France.

Additional factors, such as consumers' attitude, equipment rate of consumers' electronics and of lighting have been reviewed but their impact is non-significant on the observed differences.

Electricity is 50% cheaper in France; it certainly plays a role, but remains to be quantified.

In order to quantify the respective impact of these factors, we have calculated fictive consumption for Germany adjusted to France's specificities. First, we adjusted each factor respectively, and then we combined all adjustments (equipment rate, size, energy label penetration, technical features, and consumers attitude).

The results show that only two of the five adjustments significantly impact consumption: the equipment rate factor, ad the energy label penetration; however, they tend to offset each other. **As a result, the five adjustments only account for 21% of the performance gap observed between France and Germany, i.e. 125 kWh for an initial difference of approximately 600 kWh.**

How could the residual gap be explained? One can think of statistical or methodological bias, and of factors such as prices, policies and all qualitative factors reviewed above, which could not be quantified.

The main statistical problem that comes to mind concerns the breakdown between thermal uses and specific uses in France. Indeed, the report focused on the study and comparison of 4 components of specific electricity consumption: large domestic appliances, consumers' electronics, lighting, and small electric appliances. For Germany, it was possible to breakdown almost the total specific electricity consumption according to the four components, with a very small residual factor. For France, the same process led to an unexplained considerable residual consumption. One explanation could partly lie in the fact that the residual consumption is due to thermal use of electricity. As a result, the present report recommends auditing the breakdown of electricity consumption per use, by comparing various assessment tools and methodologies.

The quality of the available data used to calculate the various appliances' specific consumption can be questioned. There is a definite lack of expertise and validation process of these data in France.

Furthermore, although we had access to a very detailed product database, we had to use sales data between 2004 and 2008 to form the adjustments between the two countries, when differences between equipment stocks are more meaningful (in terms of equipment size and appliance types).

Moreover, all observed differences could not be quantified, as only the five most important adjustments were calculated. The fact that in France electricity costs half the tariffs in Germany may have also impacted consumers' attitude, but could not be quantified.

Finally, the analysis of the policy and instruments factors in France and in Germany shows that the situation is quite similar in the two countries, with the important exception that Germany has implemented public awareness programmes for longer that France, and with more continuity.

Germany further has two other advantages over France; they may be difficult to assess and quantify, but certainly have a positive influence on consumers' attitude concerning electricity consumption:

- German consumers declare to give more attention to environmental issues; they value brands perceived and "quality", and they assess their needs before buying a domestic appliance; this is the consequence of long years of consistent awareness programmes.
- German households also benefit form numerous DSM programmes implemented locally by Länders, cities, and more than a thousand electricity providers, some of which belonging to local authorities who have often been proactive in DSM programmes for decades.