Energy strategy programs in Canton of Vaud of Switzerland: Specific actions

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Abstract:
The goal of this paper is to give an overview about energy policy in the canton of Vaud of Switzerland with a special focus on the new cantonal strategic energy programs. Considering the global warming and limited energy resource issues as well as international energy regulations, Switzerland has set self-energy strategies for the horizon of 2050, called as “Swiss energy strategy 2050”. In accordance with the Swiss Confederation, the canton of Vaud has set strategic objectives to develop renewable energies, to ensure security of energy supply and to promote energy efficiency. With these perspectives, several specific actions have been launched, among which the three programs of Energy Audit of Large Consumers (EALC), Energy Saving Buyback through Tender (ESBT), and Territorial Energy Planning (TEP) will be described in detail.
A novel Energy Audit program for Large Consumers (EALC) has been proposed to encourage companies to optimize their energy consumption. With 33% of final energy consumption in the canton of Vaud, large consumers represent an important target for energy saving and have been mentioned in the revision of the cantonal energy law with the obligation for energy efficiency. This program is emphasizing on the multiple benefits linked to the energy efficiency measures. Its main feature in addition to the economic benefit is helping companies to improve their competitiveness by considering three components: adding a value, decreasing their risk exposure and cost reduction.
The Energy Saving Buyback program through Tender (ESBT) is another encouragement action proposed within a similar vision. The ESBT addresses the importance of improving the efficiency in companies even before promoting renewable energy sources. The subsidy attribution is merit based and will be granted to project drafts with the best value for money and energy efficiency.
In the framework of regional and local development, the program of Territorial Energy Planning (TEP) has been proposed to promote the use of renewable energy and to better integrate energy infrastructures in land-use planning.
The TEP program determines the energy supply strategies for each land development planning in the canton of Vaud using the estimated existing and future energy demand and the potential of renewable energy.
The proposed programs are part of the canton’s plan to reduce CO2 emission to 1.5 million tons and to increase the renewable energy share in total energy consumption up to 30% by 2050.

Keywords:
Energy Strategy, Energy Efficiency, Large Consumers, Territorial Energy Planning, Energy Tender

1. Introduction

The goal of this paper is to give an overview of energy policies and actions undertaken at the cantonal level at the canton of Vaud in Switzerland with the main focus on three specific energy programs: Energy Audit program for Large Consumers (EALC); The Energy Saving Buyback program through Tender (ESBT) and Territorial Energy Planning (TEP). The Canton of Vaud is the third largest of the Swiss cantons by population (9.4% of Swiss population live in Vaud) and fourth by size. The energy consumption of Vaud is around 8% of total Swiss energy consumption.

1.1 – Energy sector overview in Switzerland

Energy policy making in Switzerland: in the field of energy, Swiss cantons share some of their policy making power with the Confederation. The Article 89 of the Swiss Federal Constitution regulates this interference. The Confederation shall legislate on the use of energy by installations,
vehicles and appliances. It shall encourage the development of energy technologies, in particular in fields of energy saving and the renewable energy sources.

The technical standards for appliances, transportation, etc. are the sole responsibility of the Confederation, while the field of the building energy remains as the core competency of cantons. Cantonal legislations may deal with the energy performance of buildings, but also the energy efficiency of heating, ventilation and domestic hot water. Cantons also have the authority to set the maximum proportion of fossil fuel use.

**The "Energy Strategy 2050"**: in 2011, the Swiss Federal Council and Parliament decided that Switzerland is to withdraw from the use of nuclear energy on a step-by-step basis. The profound changes have been observed for a number of years in the international energy arena with some growing challenges in terms of the security of energy supply, the depletion of fossil fuel reserves, global climate change, the limited lifespan of nuclear power stations, and the expiration of long-term power import contracts.

![Energy Consumption Chart]

Fig. 1. Total energy consumption of Switzerland: a comparison between today and in 2050 with the "Energy Strategy 2050" package of measures [1]

The Energy Strategy 2050 is a package of long-term energy policies and guidelines proposed by the Confederation and corresponding to a plausible energy transition. It implies an early abandonment of nuclear energy and decommissioning existing nuclear plants before the end of their normal operating period on the terms of safety technology. It targets to massively reduce energy consumption and emissions of greenhouse gases by a proactive policy. This commitment translates into an accelerated deployment of new renewable energy and new technologies for energy efficiency. This scenario requires an alignment of the objectives for greenhouse gases reduction with those of the European Union, in order to conserve the competitiveness of Swiss companies. The 2050 energy strategies include specific and quantifiable targets. It is especially intended to reduce the global energy consumption per capita by 54% and the electrical energy consumption per
capita by 18%. The Federal council is considering as a part of the Energy Strategies 2050 to reduce the emissions of CO₂ from 6.5 t/CO₂ per capita per year in 1990 down to 1.0 to 1.5 t/CO₂ in 2050.

In terms of concrete measures that the confederation has implemented in recent years in compliance with the “Energy Strategy 2050” and which will probably continue until 2021, there are programs related to building. It consist of financial aids granted to building owners in order to encourage energy rehabilitation (insulation) of their buildings and is funded through a tax on fossil fuels (CO₂ tax). This initial package of measures is based on the idea to exploit the efficiency potential that Switzerland can already achieve with its existing technologies which do not require an international coordination of energy policy or additional cooperation.

It is important to mention the landmark horizon of 2021, because the confederation plans to move from this point forward, toward an incentive system based on the taxation of energy agents. These taxes are not looking forward to bail out public funds, but it is rather a guidance system since tax revenues will be redistributed to companies and citizens probably through social insurance as is the case today for some of the CO₂ taxes.

![Fig. 2. Energy consumption and resources in Switzerland [2]](image)

**Current energy usage:** the current total energy consumption and the structure of the energy resources is represented in the Fig. 1. It resumes the energy situation and resources at present and highlights projected values for the reference year 2050 in line with the Swiss Energy Strategy 2050. According to 2050 goals, the structure of energy resources will be nearly switched between the renewable and non-renewable resources. The coal and nuclear energy is abandoned and the part of the petroleum fuel is reduced from today's 53% to as low as 14%. The Swiss energy Strategy is not only about clean energies but also about energy efficiency which has to be improved to save as much as 40% of the current consumption in horizon of 2050.

The total energy consumption of Switzerland is also surveyed by sector for the period of 1910-2014 in Fig. 2. An important observation for 2014 and 2013 is the influence of recently mild winters on reduction of winter heating energy consumption which makes the total energy consumption decrease, even if the influential factors of energy consumption are growing, such as GDP (+2.0%) and permanent resident population (+1.2%).

### 1.2 – Energy policy in the canton of Vaud

**Current energy situation:** The evolution of consumption of the various energy resources of the canton of Vaud is illustrated in the Fig. 3.
During 2001-2014 the consumption at Vaud has first increased from 18.3 TWh to reach its peak at 2010 (19.7 TWh) and then decreased, with the only exception of 2013, to reach 18 TWh, nearly 2% less that the consumption level of 2001. During the same period the cantonal energy basket structure also has been changed. The petroleum fuel consumption has been significantly reduced by 42% compared to 2001 and for the first time since 1996, the coal has been disappeared as an energy resource form the canton's energy basket. This might be in part because of the generally more mild winters among others. The electricity consumption is increased by 18%, and gas by 25%, apparently replacing the petroleum fuel part. During 1996-2014, the total energy consumption at Vaud has been constantly representing 7.5% to 8% of the total Swiss energy consumption.

![Energy consumption evolution per sector in Vaud](image)

**Fig. 3. Energy consumption evolution per sector in Vaud [3]**

**Cantonal energy objectives:** in accordance with the confederation, the canton of Vaud has developed its proper objectives. Cantonal energy policies aims to improve the energy efficiency, reduce energy consumption, develop the part of cantonal production in renewable energies and ensure safe and consistent supply with environmental protection (reducing dependence on fossil fuels). The canton has notably self-set the objective to increase the part of the renewable energies to cover up to 17.5% of the total energy consumption in 2020 and to 30% in 2050, instead of its proportion of approximately 6% in 2004. A major effort to reduce the CO\textsubscript{2} emission is also expected to gradually decrease the emissions from 3.1M tons in 2004 to 2.5M tons in 2020 and then down to 1.5M tons for 2050.

**Main instruments:** in order to conduct its energy policy, the canton has developed various instruments. Canton's key policy guidelines are instructed in the "Cantonal Energy Design", adopted by the State Council in 2011, serving as the reference to be reviewed for any future legislations in the cantonal parliament. The Vaud energy act revised in 2014 (LVLEne) remains as the main legislative act specifically treating the energy policy, even if it is increasingly common to devote sections of other acts such as the Law on spatial planning to energy driven topics, for instance territorial energy planning.

The program "100 million for energy efficiency and renewable energy" is another key instrument implemented by the canton which is reviewed in the following section.

The Energy Fund has been also developed by the canton to set up a share fund for the energy sector which is supplied by the electricity tax introduced in 2006 and which finances the promotion of renewable energy and energy efficiency.
Deploying the above mentioned instruments, the following new legal steps have been undertaken by the cantonal administration.

- **Advisory Commission for the promotion and integration of solar energy and energy efficiency**: the new Vaud energy act establishes a commission whose purpose is to promote the use and integration of solar collectors and heat insulation, notably when it is consisting of cultural buildings of grand importance of natural sites. The committee, which plays an advisory role, will consulted by the municipalities in case of issuance of a building permit raising sensitive attention.

- **Cantonal energy certificate for buildings**: this new certificate shows how a residential building, an office building or a school, consumes energy at its standard rate of usage of heating, domestic hot water, lighting and other electrical consumers. It allows a comparison with other buildings, offers optimization measures. The revision of the Vaud Energy Act introduces the requirement to establish an energy audit and the cantonal energy certificate for buildings at the owner's expense, in residential transactions.

- **Goals for Large Consumers**: this action mainly concerning the industrial energy sector is devoted to industrial groups classified as "large consumers" and is discussed in detail in section 3.

- **Territorial Energy Planning**: this action is looking forward to incorporate energy saving concepts and renewable energy integration in spatial planning. An overview of ongoing programs is reviewed in the next section.

### 3. Specific actions of Canton of Vaud

In order to reach the objectives detailed in the previous section, a set of prioritized and specific actions have been derived by the cantonal administration. In this chapter first the new legal implications for major energy consumers is reviewed along with the encouraging measures to help those industries align their energy consumption with cantonal and confederation objectives.

Until now most of the energy related actions in canton have been oriented to the building sector. There is a growing tendency in public administration however to investigate other possible domains of actions in order to increase the momentum. Among these various ongoing developments, four specific programs are brought here in more details. Newly introduced cantonal legal obligations targeting large energy consumers have been inspired by federal strategic recommendations, which each canton has to interpret and implement through specific actions. Along with the Vaud's definition for large consumers and their obligations, public administration has also implemented supportive measures to accompany the transition. The specific program of "100 million for renewable energy and energy efficiency" is a unique supportive measure in the domain and has been implemented for this purpose. One of the main opportunities to increase the efficiency of canton's initiatives is to approach and accompany municipalities. Vaud has been composed of multiple municipalities, which because of their small population are often deprived from confederation's supportive programs. Canton of Vaud has therefore created the Energy Concept municipality initiative to develop the energy–related objectives through all municipalities regardless of their size.

#### 3.1. Large energy consumers

Inspired by the federal law of energy, the revised Vaud energy act in 2014 have introduced new provisions concerning large energy consumers: Large consumers must agree to take energy efficiency measures; they sign agreements on objectives or conduct the analysis of their energy consumption and implement reasonable optimization measures.
According to the new definition of the law a Large Consumer (LC) is an energy consumer with an annual thermal energy consumption exceeding 5 GWh and/or whose annual electricity consumption exceeds 0.5 GWh, (i.e. the consumption of about 140 households). Nearly 600 LC sites are identified in the canton of Vaud which represent about 33% of the energy consumption of the canton.

Any new project entering the LC category is subject to a specific permit issued by the Cantonal authority and those LC project owners have to analyze several alternatives for energy efficiency and renewable energy supply, otherwise, the most energetically favorable may be imposed by the canton. The existing sites now categorized as LC have to undertake (individually or as groups) actions on energy efficiency. Three options are available to them: Apply a target agreement specified by the Confederation, Apply a target agreement established with the Canton or analysis of energy consumption, followed by the implementation of the most cost-effective measures.

In some cases, the canton may impose specific measures to LCs. These measures however have to correspond to the state of the art of the technology, to be cost effective over the life cycle of the investment and do not cause significant inconvenience to the LC's production level or their current maintenance. Grants may also be granted for carrying out energy audits. These grants are awarded under the program: "100 million for renewable energy and energy efficiency" which is reviewed in the following lines. The results of these audits will allow the LC sites to determine which of the three execution options would be best suited to theirs interests.

3.2. Program of 100 million for renewable energy and energy efficiency

Even prior to the new energy act and following the incident at Fukushima and the decision of the Confederation to the nuclear phase-out, it is decided to allocate the total sum of 100 million francs for renewable energy and energy efficiency. This program will fund nine type of actions:

- Building rehabilitation
- Audits of large energy consumers
- Feed-in remuneration at cost for photovoltaic and wet biomass electricity
- Biomass energy development
- Support for biogas from wet biomass
- Support for various hydraulic electricity projects
- Support for energy related university projects
- Support for training and advanced studies in the field of energy
- Information and encouragement measures

Two main programs have been branching out of the program of 100 million, the program for Energy Audit of Large Consumers (EALC) and Energy Saving Buyback program through Tender (ESBT), which both are reviewed and commented in detail in the following chapter.

3.3. Energy concept of municipality

Based on the Vaud energy Act, which encourages municipalities or groups of them to participate in the implementation of energy policy, the Canton offers tools to facilitate the development of the communal energy concept. This action mainly targets municipalities with less than 3'000 inhabitants for whom there have been few suitable tools until now. For the more ambitious municipalities, the development of an energy concept can be the first step towards the Energy City label.

The energy concept will serve as a guideline for municipal decisions on energy, based on a long-term vision and goals. It also suggests ways to achieve these goals. With the energy concept
procedure, each municipality is committed to an active energy policy. This will enable the municipality to reduce its consumption of non-renewable energy and to increase production and the share of renewable energy in its consumption. Consequently, it will comply with the Confederation objectives regarding the reduction of CO\textsubscript{2} emissions of Switzerland. Through its commitment, it also wants to encourage the residents of the municipality to actively engage and participate in the actions it undertakes.

4. Selected energy strategy programs of canton of Vaud

4.1. Energy Audit of Large Consumers (EALC)

**Introduction and objectives:** Considering the policy changes and new law establishments targeting the large consumers, Canton of Vaud launched the new program of Energy Audit of Large Consumers (EALC) in order to encourage companies to take a proactive approach to energy management. The EALC aims to encourage stakeholders to undertake actions to optimize their consumption with a perspective to improve their competitiveness.

In summary, the energy audit carries a diagnosis of energy consumption of a site and establishes a catalogue of energy saving measures technically feasible and economically viable, accompanied by recommendations. To ultimately achieving the energy savings, this program should provide the audited company with the decision-making groundwork concerning the actions to take to improve its energy efficiency. The ELAC audit concerns buildings, production installation and equipment and only accredited person can realize the audit. The role of the canton in addition to the financial support, is to provide reference documents and evaluation tools and also to give necessary information and direction to professionals who perform the energy audits.

The program objectives are:

- Providing deliverables in accordance with the application of articles on LC
- Establish a catalog of Energy Performance Actions (EPA), quantify their profitability and prioritize them
- Deliver to the company the necessary elements enabling decision making and the preparation of its action plan

**ELAC program phases:** The EALC program is defined in three phase:

- **The pre-diagnosis phase:** This phase monitors the energy consumption of the site and identifies the strategies of the company. A fixed-package grant based on the energy consumption of the company is considered to cover a large part of the mandate of the audit office for this phase. The objectives of this phase are particularly linked to the core-business of the large consumer and its specific criteria for investment. They are in brief:
  - Evaluate the energy situation of the company
  - Identify objectives, constraints and decision criteria for energy performance actions (EPA)
  - Make recommendations: Monitoring consumption, energy management, skills needed for diagnosis

Often, even very profitable EPAs are not implemented because they are not always seen to be strategic. Energy projects interfere and are often set aside in competition with other company's investment projects. The company however will promote a project as soon as it is considered to be strategic. For the program to be successful, it must be a close link between the technical measures and values, strategic goals of the company and the company’s investment decision modes. In order to positively influence investment decisions of EPA a quiz test was created (Business strategy: Eco diagnosis [4], Technical engineering: Planair SA [5]) to evaluate the level of energy management of a company, to clarify its internal
situation and to identify the barriers and factors that favorably influences the adoption of EPAs.

- **The diagnosis phase**: It systematically reviews the energy usages (buildings, technical installations and processes), establishes a catalog of encrypted savings actions (savings, investments and payback time in particular) and lists the priorities. The grant is determined based on the data provided in the pre-diagnosis phase, mainly the annual energy consumption, the energy saving potential and complexity of diagnosis. The amount is capped at 60% of the mandate for the office of the auditor. The objectives of this phase are:
  - Systematic review of energy use (buildings, technical installations and processes)
  - Establish a catalog of encrypted EPAs and define the advantages of each action (economical (cost) and non-economic (value and risk))
  - Establishment of an action plan that might addresses the legal provisions

- **The through audit phase**: It consolidates technically and / or economically, the high-stakes actions for which the assessment remains too imprecise to make a decision at the end of diagnosis phase. Except certain cases that necessarily require further diagnosis, no grant has been considered for this phase. The objectives of this phase are:
  - Define in more detail or consolidate the content of one or more actions recommended in the diagnosis phase and identify their technical or economic constraints and implications
  - Provide recommendations for the implementation of the EPA

**Case study**: The total numbers of 70 pre-diagnosis cases have been analyzed to survey the level of energy management in large consumers of canton of Vaud. This number corresponds to 70 companies and around 12% of the large consumers of Vaud.

**Table 1. Key facts of energy audit program**

<table>
<thead>
<tr>
<th>Analyzed cases</th>
<th>70 companies, Apprx. 12% of large consumers in Vaud</th>
</tr>
</thead>
</table>
| Energy consumption | **Total**: Electrical (190 Gwh/y); Thermal (174 Gwh/y)  
**Average**: Electrical (2.7 Gwh/y); Thermal (2 Gwh/y) |
| Energy cost | 3% of the turnover |
| Auditors | 7 consulting firms and total of 15 auditors |
| Companies | **Activity sector**: Several sectors concerned, among which 10 high-tech sites, 8 pharma and 4 hospitals  
**Size**: total number of 15'000 employees concerned, in average 211 empl/site |
| ELAC diagnosis note |  
> 18 (14 companies); 17 > > 11 (23 comps.); 10 > > 6 (16 comps.); < 5 (16 comps.); 11/22 in average; |
| Energy management level | Have energy strategy (42 comps.); Already performed an energy audit (37 comps.); have energy efficiency measure in place (33 comps.); have implemented internal energy awareness measures (27 comps.);  
Only 16 companies have all those criteria satisfied simultaneously  
40 Companies have established internal energy norms |

The result of analysis shows that the energy auditors often succeeded to initiate a process of awareness if it was not there yet and also many companies have a good level of energy management. Many leaders among large energy consumers believe that the new provisions will help to highlight the role of energy in their structure. The questionnaire about the level of energy
management, the context, barriers and the positive aspects were found to be a powerful tool for analyzing a company. Table 1 represents some of the key facts from the pre-70 diagnosis.

According to the pre-70 diagnosis, the most influential constraints companies are facing with against implementing an EPA and the most promising features motivating them to move toward it are presented below in Table 2, sorted based on their importance.

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Motivating features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget constraints</td>
<td>Reduction of energy costs</td>
</tr>
<tr>
<td>Higher priority of other investments</td>
<td>Improvement of customer comfort and image</td>
</tr>
<tr>
<td>Return on investment</td>
<td>Reduction of non-energy costs</td>
</tr>
<tr>
<td>Current installation sufficiently efficient</td>
<td>Subsidies and grants</td>
</tr>
<tr>
<td>Negligible energy costs</td>
<td>Reduction of production risks</td>
</tr>
<tr>
<td>Energy efficiency has a low priority</td>
<td>Improvement of comfort for collaborators/loyalty</td>
</tr>
<tr>
<td>No vision about technologies</td>
<td>Avoid supply risks</td>
</tr>
<tr>
<td>Doubts about the quality of technologies</td>
<td>Reduction of price increase risk</td>
</tr>
<tr>
<td>Difficulty to obtain the credit</td>
<td>Tax reduction</td>
</tr>
<tr>
<td>Credit demand refused</td>
<td>Improving the production/process</td>
</tr>
</tbody>
</table>

4.2. Energy Saving Buyback through Tender (ESBT)

The ESBT is a competitive merit-based grant program with defined funding limits. Only the most efficient proposals that successfully meet the assessment criteria will be funded.

In general, the energy saving and CO₂ emission reduction potential is significant in companies (industry, services, crafts). However, even profitable projects with sufficiently incentive payback time, have difficulty to benefit from fundraising. On the one hand, access to funds for energy efficiency measures in companies is often undermined by internal competition in terms of investment priorities. Indeed, companies prefer investments directly related to their core business and they often neglect the financial benefits of investment in energy savings. This is especially true for the measures the return on investment exceeds 2 to 4 years. On the other hand, a few banking organizations provide credits for such operations, as they do not know the related risks.

This program aims to provide energy savings deposits for companies close to the breakeven point. Its main objectives are:

- Establish an energy saving buyback program through competition in the form of call for proposal
- Promote investment in energy efficiency measures
- Support companies subject to investment difficulties in the context of the strong Swiss franc appreciation

The total available budget is 2 million franc, and it is planned to be attributed by 2 slices of 1 million franc each. In order to respect the competitive character of this program, the budget will be reduced proportionally if the sum of the eligible applications does not reach 120% of the maximum budget. Moreover, in order not to cumulate the money only in few companies, the maximum contribution per project is considered to be CHF 100,000. Also, the projects with a requested the contribution less than CHF 10,000 cannot be taken into account.
The maximum financial aid is between 15% up to 50% of the total project investment. The age of the equipment or existing installations which must be renewed is the decisive criteria in defining the maximum rate of financial aid: the older the existing facility is, the lower the maximum rate of financial aid will be. However, this only limits the maximum rate of financial aid. Applicants may apply in their project proposals a lower rate in order to increase the likelihood of receiving a grant in a bidding competition.

Applications will be evaluated in three phases. In the first phase, the acceptability of all applications is evaluated based on the eligibility, admissibility and viability criteria. The eligibility criteria are defined as the criteria that the applicant must be respected by default, and if one of these criteria is not met, the application will be subject to immediate dismissal. An application will be accepted for further assessment if it meets all of the eligibility criteria. Example of such a criteria: only the energy efficiency actions that result to consumption of less energy while providing the same service are considered as acceptable measures, or the measure should realize in the state of Vaud territory. Another significant criteria is that only the proposals with the payback time more than 2 years are accepted. The reason for this is behind the fact that a project with a payback time less than 2 years is already enough attractive for the companies to investment in. The applicant's justify the viability criteria on the other hand, can be modified, it means if they are not satisfied, the application is not rejected immediately, but the company is informed to change its application. Example of such a criteria: the duration of proposed projects should not exceed more than 36 months. Finally, the companies must justifying the viability criteria, for example, the financial viability of the proposal or the applicant's ability to complete the project.

The proposals selects through a bidding process, in which the accepted requests are subject to the tender procedure, in the second phase of evaluation. The assessment is based on the merit criteria. The proposals is evaluated based on the eligibility, admissibility and viability criteria. Example of such a criteria: only the proposals with the payback time more than 2 years are accepted. The reason for this is behind the fact that a project with a payback time less than 2 years is already enough attractive for the companies to investment in. The admissibility criteria on the other hand, can be modified, it means if they are not satisfied, the application is not rejected immediately, but the company is informed to change its application. Example of such a criteria: the duration of proposed projects should not exceed more than 36 months. Finally, the companies must justify the viability criteria, for example, the financial viability of the proposal or the applicant's ability to complete the project.

**Energy efficiency**: it refers here to the amount of energy that can be saved through implementation of energy measures. The annual energy saving for energy source $i$ of energy measure $j$ ($\Delta E_{ij} \left[ \frac{\text{kWh}}{\text{year}} \right]$) is calculated as the difference between the energy balance before and after the implementation of the measure.

### Annual energy saving for energy source $i$ of energy measure $j$:

\[
\Delta E_{ij} \left[ \frac{\text{kWh}}{\text{year}} \right] = (\Delta E_{ij,\text{before}} - \Delta E_{ij,\text{after}}) \left[ \frac{\text{kWh}}{\text{year}} \right] \tag{1}
\]

\[
\Delta E_{ij,\text{before}} \left[ \frac{\text{kWh}}{\text{year}} \right] = (E_{ij,\text{before}}^+ - E_{ij,\text{before}}^-) \left[ \frac{\text{kWh}}{\text{year}} \right] \tag{2}
\]

\[
\Delta E_{ij,\text{after}} \left[ \frac{\text{kWh}}{\text{year}} \right] = (E_{ij,\text{after}}^+ - E_{ij,\text{after}}^-) \left[ \frac{\text{kWh}}{\text{year}} \right] \tag{3}
\]

Where for energy source $i$, $E_{ij,\text{before}}^+$ and $E_{ij,\text{after}}^+$ are the annual energy consumption before and after the implementation of the measure $j$, and $E_{ij,\text{before}}^-$ and $E_{ij,\text{after}}^-$ are the annual energy production before and after the implementation of the measure $j$, respectively.
To calculate the total energy saving (see (4)) including all types of energy sources, each calculated energy saving is multiplied by a corresponding weighting factor \((f_{i,w})\) (see Table 3) that is defined by Swiss Federal Office of Energy (SFOE). This factor allows converting the energy consumption of each measure into a comparable value. The total energy saving for all energy measures can be calculated using their corresponding lifetime \((L_{j,t})\).

**Total energy saving for \(n\) energy measures:**

\[
\Delta E_{\text{total}} \ [\text{kWh}] = \sum_{j=1}^{n} \left( \sum_{i=1}^{m} \left( \Delta E_{i,j,\text{before}} - \Delta E_{i,j,\text{after}} \right) \right) \left[ \frac{\text{kWh}}{\text{year}} \right] \left( f_{i,w} \right) \left( L_{j,t} \right)
\] (4)

**Table 3. Multiplication factors for each energy resources [6]**

<table>
<thead>
<tr>
<th>Energy resource</th>
<th>Multiplication factor ((f_{i,w}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petroleum fuel</td>
<td>1.0</td>
</tr>
<tr>
<td>Gas</td>
<td>1.0</td>
</tr>
<tr>
<td>Coal</td>
<td>1.4</td>
</tr>
<tr>
<td>Biomass</td>
<td>0.7*</td>
</tr>
<tr>
<td>Biogas</td>
<td>0.7*</td>
</tr>
<tr>
<td>Thermal solar energy(^{\circ})</td>
<td>0.5*</td>
</tr>
<tr>
<td>Distributed heat from waste treatment sites</td>
<td>According to the fuel mixture</td>
</tr>
<tr>
<td>Thermal waste(^{\circ})</td>
<td>0.7*</td>
</tr>
<tr>
<td>Electricity</td>
<td>2.0</td>
</tr>
</tbody>
</table>

\(^{\circ}\)This energy source would be considered only if the energy savings in this category was used for other purposes.

\(^{\circ}\)The weighting factor for this energy source is different from the recommended value by SFOE [6] corresponding to the specific objectives of this program.

**Value for money** \((\varepsilon)\) it is expressed by the ratio of the requested fund from the canton \((\text{investissement}_{\text{canton}})\) to the total energy saving.

\[
\varepsilon \left[ \frac{\text{CHF}}{\text{kWh}} \right] = \frac{\text{investissement}_{\text{canton}} \ [\text{CHF}]}{\Delta E_{\text{total}} \ [\text{kWh}]} \] (5)

Final score composed of 70% of the score of the value for money and 30% of the other. The projects will be selected starting by the best score until depletion of the first tranche of the tender.

The result of similar tender program in Switzerland shows that the average value for money for a successful project is around 0.03 \([\text{CHF/kWh}]\). Considering the total weighted energy consumption of canton of Vaud as 21.08 \([\text{TW h/yr}]\), the predicted energy efficiency improvement through this project is 0.04%. The calculation detail is summarized in the Table 4.

The fact that the ESBT program will have a very low direct quantitative impact illustrates the massive investments that the public sector will have to make for energy efficiency purposes. The fact of implementing such encouragement programs however sends also a strong political message whose indirect impacts cannot be easily quantified.
Table 4. Calculation of the predicted energy efficiency improvement

<table>
<thead>
<tr>
<th></th>
<th>Estimated value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average lifetime</td>
<td>15</td>
<td>Year</td>
</tr>
<tr>
<td>Average value for money</td>
<td>0.03</td>
<td>CHF/kWh</td>
</tr>
<tr>
<td>Total budget</td>
<td>2000</td>
<td>k CHF</td>
</tr>
<tr>
<td>Total energy saving by companies per year with weighting factor</td>
<td>8.9</td>
<td>GWh/Year</td>
</tr>
<tr>
<td>Total energy consumption of Vaud with weighting factor</td>
<td>21.1</td>
<td>TWh/Year</td>
</tr>
<tr>
<td>Estimated energy efficiency</td>
<td>0.04</td>
<td>-</td>
</tr>
</tbody>
</table>

4.3. Territorial Energy Planning (TEP)

Territorial energy planning was introduced in the revision of the Vaud Energy Act, came into force in July 2015. This initiative aims to facilitate the integration of renewable energy and the implementation of necessary infrastructure for their distribution. It is also to optimize the energy efficiency of buildings through the spatial planning measures, such as building orientation and proximity to renewable resources or waste heat. A long term goal is to find a balance between the energy needs and the resources available locally.

In practice, this process is conducted by a study whose conclusions are incorporated in measures and actions in development Land-use plans. In the canton of Vaud, the territorial energy planning is notably required when dealing with urban agglomeration programs, regional development plans or municipal master plans for the municipalities belonging to a center. The main goal is to make the concerned municipalities have a coordinated strategy for their energy supplies, to promote the locally available renewable energy and the waste heat. At the municipal level, this strategy provides a reference for the district plans.

The development of a territorial energy planning is performed in three steps. The first step is to establish an energy audit of the territory, with its current and future supply needs. The second step is a projection into the future with estimated energy needs, the potentially available resources in the territory. The outcome of this second step is the possible scenarios to cover future needs. The third and final step is to define an energy strategy for the territory for the most plausible scenario among the ones developed in the previous step. To help achieve this scope, the canton will publish a methodological guide for municipalities and professionals. It also subsidizes these studies up to 50%.

Case study: "creation of a district heating network based on the use of the Geneva lake water in La Tour-de-Peilz"

Project Summary: following a territorial energy plan, the core study for this project has been initiated in 2010 in partnership with the Municipality of La Tour-de-Peilz, the Canton of Vaud and the Groupe E SA. The main idea has been to use the Leman Lake as a source of renewable energy to provide heating services and hot water to different parts of the municipality of La Tour-de-Peilz. The water pumped from the lake warms a loop circulating in a closed circuit in a network serving as a source of energy for heat pumps installed in buildings. The only energy to be provided is electricity, for pumping and circulating the water, as well as for the operation of heat pumps. This system has been employed in much smaller scale (with the exception of Lake Geneva Nations project) but represents a substantial potential. This energy potential is estimated to represent nearly 580 MW for the Leman Lake according to a study of the EAWAG - Research Institute water of the ETH [7]. This system has also a particular interest when cooling and refrigeration services are needed. In 2012, a comparative study of the Industrial Energy Laboratory of EPFL [8], confirmed
also that the project was one of the most attractive solutions for this territory from energy and environmental point of view. Network construction began in 2014, with the first buildings planned to be heated in 2015.

Canton's contribution has been crucial for this project because of the high amount of the required one-time investment which would be then paid back in a 25 year period of service. Canton of Vaud contributed to this project with approximately CHF 1.9 millions.

Table 5. Project key facts

<table>
<thead>
<tr>
<th>Connectable Buildings</th>
<th>Apprx. 370</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power</td>
<td>18.7 MW</td>
</tr>
<tr>
<td>Annual Thermal Energy</td>
<td>35'317 MWh</td>
</tr>
<tr>
<td>Annual Electricity</td>
<td>10'879 MWh</td>
</tr>
<tr>
<td>Total investment</td>
<td>CHF 63 million</td>
</tr>
<tr>
<td>Canton's contribution</td>
<td>Apprx. CHF 1.9 million</td>
</tr>
</tbody>
</table>

The main advantages of the project have been summarized below:

- Reduces primary energy consumption and CO₂ emissions by around 60%;
- Uses the lake water as a renewable energy and is environmental friendly;
- Helps to diversify sources of supply without risk of depleting local resources;
- Represents a solution to the problem of air quality in the region which has been classified as "excessive emissions zone type 2" (that is outside a perimeter subject to an action plan);
- It is fed with the electricity as the main operating power, bearing in mind that the renewable electricity production will be gradually increasing in Switzerland. The subsequent integration of solar photovoltaic panels helps also to make the project self-sufficient;
- Once in service, it can also provide cooling facilities. Development of the cooling features will however depend on the arrival of new commercial and industrial users in the network service area and there is a potential that the overall energy and environmental efficiency of the project would even increase.

5. Conclusion

The energy sector in Switzerland is undergoing a profound change both in terms of policy-making and growing measures, which encourage use of renewable resources and CO₂ emission reduction. The current energy context, objectives and policies have been briefly reviewed for both levels of the Swiss confederation and the Canton of Vaud to show their interaction.

In canton of Vaud over 33% of total energy consumption is due to some 600 companies. Based on Pareto principle, any specific action on this group of large consumers is more likely to have major effects on total consumption and merits to have particular legislative attention. A set of yet encouraging actions help these industries gain energy awareness, evaluate existing consumption and to encourage them to take meaningful action towards cantonal and confederation goals. Public sector emphasis and encouraging/penalizing legislations on energy consumption of major consumers give the energy a strategic dimension and move it up as a viable and necessary investment alternative. This becomes particularly reasonable since as soon as 2021 the confederation transits form encouraging-only actions into more direct approaches where less attentive companies will have to assume additional charges.

Energy efficiency retribution through tender program also helps to create this competition ambiance on specific projects with high rate of return in terms of energy saving per investment. The strong
message sent through this public action and the invented momentum is more on focus than pure energy saving.

Distributed heating network is only one of examples where land-use planning comes into interaction with energy planning. This has to be seen along with the fact that buildings are among the major energy consumers at the canton. Building energy sector being under the authority of cantonal legislation, there is an opportunity to seek for positive interactions between the land-use planning and the energy saving initiatives. The canton of Vaud works tightly with municipalities on taking integrated territorial energy planning features into consideration and has supported innovative projects in this area.

References