Switzerland

Regional Energy and Climate Assessment

Picture: http://www.myswitzerland.com/en-ch/grande-dixence-dam.html

Table of contents

Introduction

Background
- Population (current status and trend)
- Economy (current status and trend)
- Carbon emissions, carbon intensity
- Current energy use, resources, and flow
- Environmental concerns and risks

Power systems (energy supply)
- Current status, including energy mix and carbon emissions
- Future energy options, considering regional suitability, capital, fuel and maintenance costs, dispatchable vs. non-dispatchable, transmission, etc.
- Projections (future growth for Business as Usual scenario)

Transportation
- Current status and projections
- Current decarbonization plans
- Enhanced decarbonization plans

Economics/Policy
- Current policies that aid or hinder the development of alternative energy sources
- Projections for changes in key economics and policies
- The potential role of cap and trade, carbon taxes, etc. in the region

Summary

Abbreviations

Bibliography

Introduction

A few months before the United Nations Climate Change Conference (UNCCC) was set to convene in Paris in 2015, Switzerland was the first country to officially and publicly communicate its goals for the conference. In a press release, the Swiss government vowed to lower its carbon emissions by 50% on 1990 levels by 2030. The Swiss government called the goal ambitious and forward-looking. Some observers were a little less enthusiastic and were disappointed with Switzerland for not going far enough. (*The Guardian* 2015) This paper aims to analyze the Swiss situation in detail, the thesis being that while the Swiss government accepts the issue of climate change as vital and has implemented various changes to lower carbon emissions, it is not enough to achieve the goals of the UNCCC.

I will start with some background about the country, its population and economy. I will also describe the current situation in terms of carbon emissions and energy use as well as environmental concerns and risks.

The following two chapters will be dedicated to two sectors which are very relevant to the question of carbon emission and climate change, namely the energy and transportation sectors. The analysis will include the current situation, options for the future and existing plans that are being discussed to achieve the goals set forth in Paris. In the chapter about energy, I have devoted some space to the current political discussion in Switzerland, where voters will be asked to express themselves on May 21 2017 on a ballot proposal about the future energy strategy of the country. The proposal which is named “Energy Strategy 2050” will implement changes to secure Switzerland’s energy independence while instituting changes in line with the Paris Agreements. It will also implement a plan to gradually exit nuclear energy.

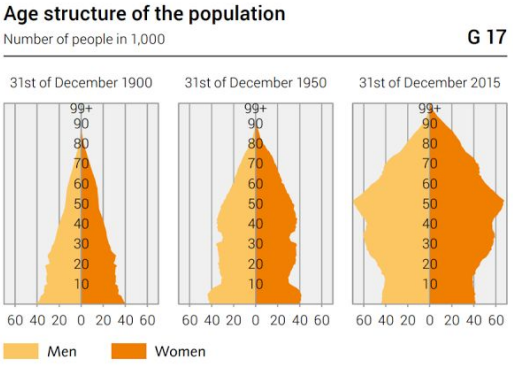
The fourth chapter looks at the economics of these policies in more detail. One area of focus are renewable energies and how they are being subsidized as well as other tools that have been implemented to reduce carbon dioxide emissions.

In the summary, I have stated my views on the thesis of the paper and the question of whether Switzerland's plans are sufficient to reach the goals of the Paris summit.

Background

Population (current status and trend)

Switzerland is a small and rather densely populated country in the middle of Western Europe. At the end of 2015, it was home to 8.327.126 people. It shares many population trends with its immediate neighbors and other developed countries. These are low population growth (1.1% at the end of 2016), a population that is growing older (life expectancy was 80,7 for men and 84,9 for women in 2015) and low fertility rates (average of 1.5 children per woman). (Office 2017b, BFS)



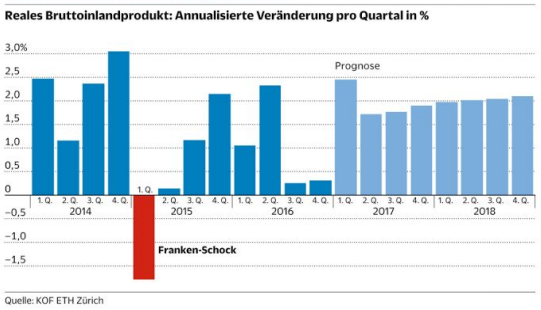
Switzerland is set somewhat apart from its immediate neighbors (France, Germany, Italy and Austria) by the size of the permanent foreign resident population. More than 2 million permanent residents or 25% do not have a Swiss citizenship. This number increased by 3% in 2015. (Office 2017b, BFS) About two thirds of the permanent foreign resident population come from countries in the European Union. There are many reasons for this large number like available jobs and good living conditions. One of the contributing factors is that naturalization is a long and difficult process and it is not

uncommon for foreigners of the third generation living in country still not to have the Swiss citizenship.

Economy (current status and trend)

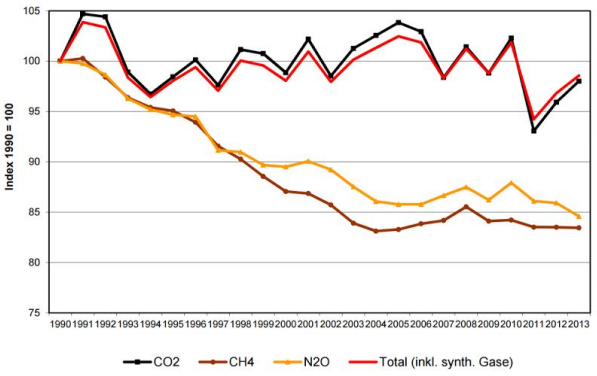
The country's gross domestic product (GDP) was estimated at $494,3 billion in 2016, up 1% from the previous year. In terms of GDP per capita, Switzerland was ranked 16th in the world with $59.400, marginally ahead of the United States which was ranked 18th with $57.300. By sector, the contribution to GDP was 0,7% from agriculture, 25,9% from industry and 73,4% from services. Switzerland enjoys a low unemployment rate of about 3% (3,4% in 2016). This is significant especially in the context of its immediate neighbors, where unemployment rates above 5% and sometimes more than 10% are the norm. ("The World Factbook — Central Intelligence Agency" 2017)

The economy's growth has been lackluster in the last couple of years. In 2015, Switzerland's Central Bank had to give up its exchange rate goal of CHF 1,20 against the Euro. As a result, the value of the Swiss Franc increased significantly, achieving parity with the Euro in early 2015. The Euro has gained some strength since then, but appreciation of the Swiss Franc has burdened the Swiss economy that is very reliant on exports. Growth was negative in Q1 of 2015 and a lackluster 0,3% in the second half of 2016. There has been more positive news recently, with the economy growing at 2,5% in the first quarter of 2017. The projections for the next couple of quarters are between 1,5-2%. (Steck 2017)

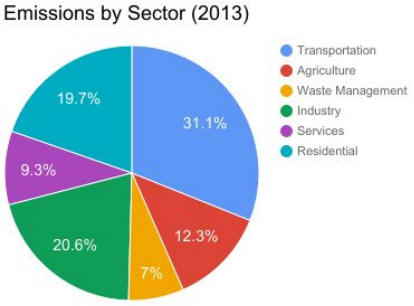


Carbon emissions, carbon intensity

In 2013, Switzerland emitted a total of 52,59 mio t CO2 eq. This number has been declining since 1990. What is interesting in this context is that the main reduction in the emission of greenhouse gases has not come from Carbon Dioxide (CO2) but from Methane (CH4) and Nitrogen Oxide (N2O). The reasons for these reductions are mainly found in agriculture. A lower number of cattle held on Swiss farms has been responsible for lowering the Methane emissions and less usage of fertilizer has lowered Nitrogen Oxide emissions. (Lerch 2015, 3)



What has been increasing rapidly, albeit from a very low base, is the emission of synthetic gases (i.e. HFC, PFC, SF6 and NF3). These emissions have increased by a factor of more than 7 since 1990. The main contribution comes from HFC, which has replaced CFC for cooling. CFC, itself a greenhouse gas, was banned in the Montreal Protocol in 1987 because of its ozone depleting faculties. (Lerch 2015, 4)



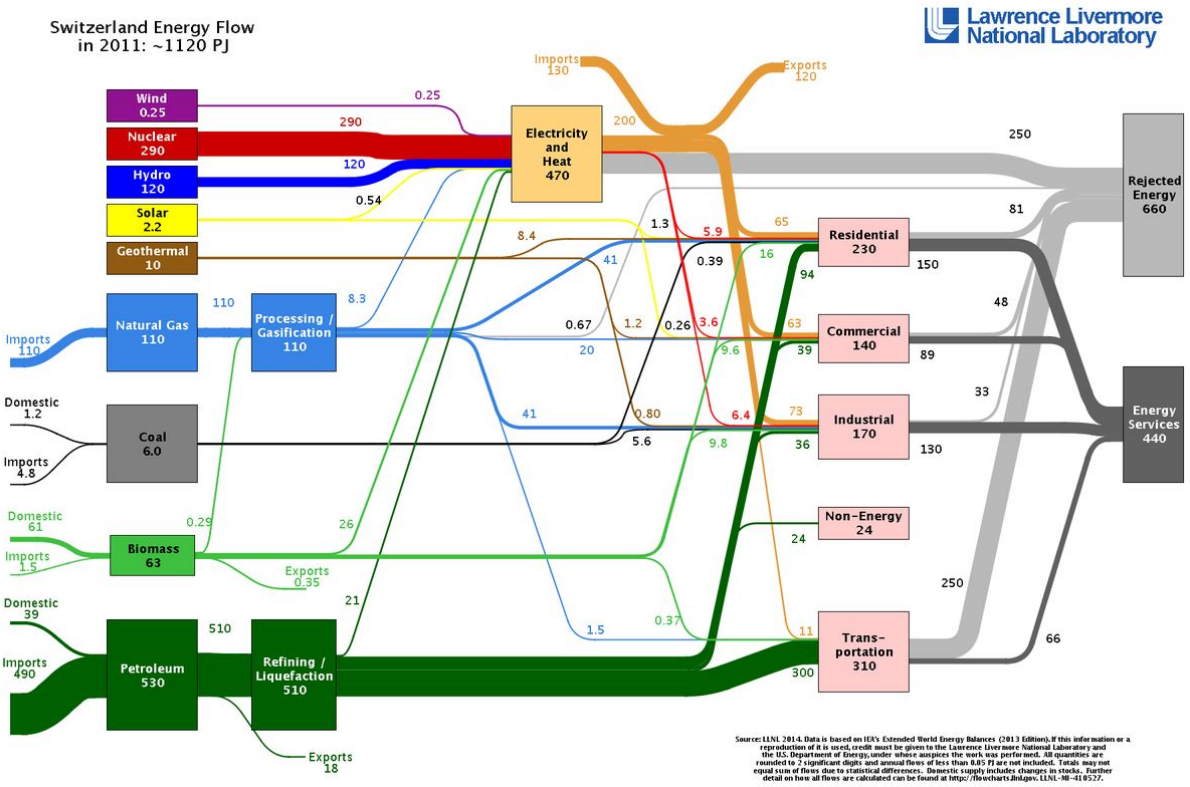
By far the greatest contribution to the emission of greenhouse gases still comes from CO2. About 82,2% of all greenhouse gas emissions are from carbon dioxide. This number has remained pretty stable since 1990, with the reduction of Methane and Nitrogen Oxide emissions being replaced by synthetic gases. (Lerch 2015, 5)

The distribution of emissions by sector is interesting as well mainly because unlike many other countries, electricity production does not factor in. More than 90% of electricity produced in Switzerland comes from hydro and nuclear power plants which are in essence carbon free. The biggest emitter of greenhouse gases therefore is transportation with 31,1%, followed by industry (20,6%) and residential (19,7%). (Lerch 2015, 7)

Current energy use, resources, and flow

Switzerland's electricity production is heavily influenced by its geographic location and topography. According to the Swiss Federal Office of Energy (SFOE)[1], 59,9% of Swiss electricity in 2015 came from hydropower plants. The other big energy source for electricity production is nuclear with 33,5%. (Office 2017a, BFS) According to the Lawrence Livermore National Laboratory Energy Flow chart, renewables until now are negligible in the Swiss energy mix with the exception of biomass, which contributes 63 PJ. Fossil fuels are mainly used in transportation (gasoline) as well as in residential, commercial and industrial use.

[1] There are significant differences between the numbers of the SFOE and the Lawrence Livermore National Laboratory when it comes to energy sources and especially hydro power. Some of the differences are explained by the years of origin (LLNL numbers are from 2011, SFOE are from 2016) but not all. I have relied more heavily on SFOE because they are more recent and can be sourced more clearly.



Picture: https://flowcharts.llnl.gov/

Environmental concerns and risks

In 2015, The European Environment Agency (EEA) published the National State of the Environment report which described Switzerland's biggest environmental challenges and risks. The report stated that policy changes in the 1980s had had a significant effect on the emission of air pollutants and that Switzerland enjoyed better air quality as a result. However, some pollutants (e.g. particulate matter, ozone, ammonia and nitrogen oxides) still regularly exceed objectives. Also a large number of chemical substances (e.g. drugs, personal care products and plant protection products) are not filtered out at wastewater treatment plants and cause damage to the ecosystem in the form of micro pollutants. ("Switzerland — European Environment Agency" 2014)

In general, Switzerland, much as the rest of the developed world, overuses nature's resources. The EEA estimates that Switzerland uses about twice as much resources that

can be sustainably provided by the Earth. This is caused by high energy consumption, increased mobility and the constant expansion of settlement and transport areas. This overuse is a major burden on the ecosystem. (“Switzerland — European Environment Agency” 2014)

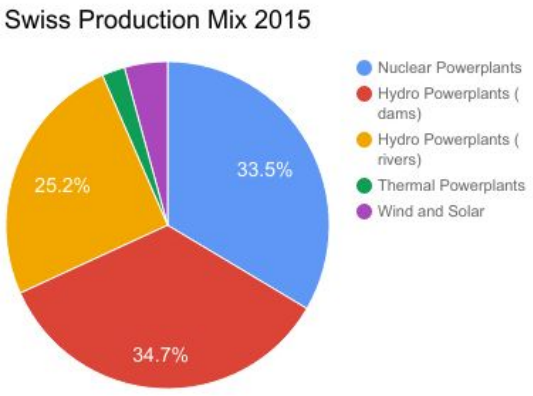
The risks associated with the concerns above are twofold. First, they pose a threat to Switzerland water resources which are a strategic asset for Switzerland’s energy production and standard of living. Switzerland being at the Source of major European rivers such as the Rhone and the Rhine, this risk also directly impacts the wellbeing of its neighbors. (“Key Aspects of Environmental Protection in Switzerland” 2017)

Second, the consequences of global warming also increase the risk of natural disasters such as floods, debris flows, landslides, avalanches and storms. (Federal Office For The 2017, FO) These natural disasters have already impacted Switzerland in a significant way and will continue to do so if we are unable to limit the effects of global warming.

Power systems (energy supply)

Current status, including energy mix and carbon emissions

In the global context, the production of electricity still represents one of the major contributors to carbon dioxide emissions. Many countries largely depend on fossil fuels for their energy production.



Switzerland produces more than 90% of its electricity from hydro and nuclear power

which is nearly carbon free. (“Produktion Und Strommix :: VSE - Verband Schweizerischer Elektrizitätsunternehmen” 2017) This production mix has been stable for many decades and reflects Switzerland’s topography with its mountains and many rivers and lakes that lend themselves to hydropower.

Future energy options, considering regional suitability, capital, fuel and maintenance costs, dispatchable vs. non-dispatchable, transmission, etc.

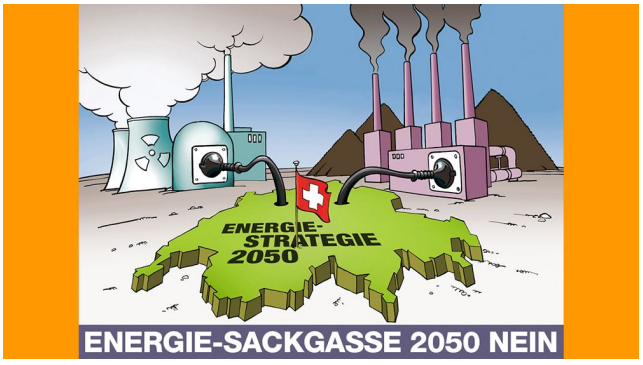
In March 2011, a few weeks after the Fukushima incident, the Swiss government committed itself to retire its nuclear power plants and exit nuclear electricity production by 2030. This decision and the commitments the Swiss government made during the UNCCC in Paris in 2015 will compel Switzerland to adapt its energy production in the coming years and replace about a third of its electricity production with other sources. Switzerland being a direct democracy, Swiss people will be called to vote on the country’s future energy strategy on May 21, 2017.

The legislation introduces changes that aim to ensure energy supply while lowering carbon emissions. Some of the steps on the ballot are:

- Development of additional hydropower capacity
- Withdrawal from nuclear power production on a step-by-step basis (when the current power plants reach their natural retirement) and a moratorium on new power plants
- Investments in additional renewable energy source like wind, solar and biomass
- New rules that increase energy efficiencies in buildings, appliances and transportation

Its aims are to reduce per capita energy consumption as well as the proportion of fossil-based energy use. The main goal is to compensate for the loss of nuclear energy in a carbon neutral fashion by increasing energy efficiency and promoting the use of renewable energy. (Federal Department of et al. 2017)

Opponents of the law have argued against the moratorium on new nuclear power plants because in their view, the potential of renewables such as wind, solar and biomass is not sufficient to compensate the loss of nuclear energy and will render Switzerland dependent on electricity produced in neighboring countries such as Germany and France. Swiss utility companies have been very active in investing into renewable power plants (mainly wind and solar) but these investments have practically all been made outside of Switzerland, where there are less regulatory hurdles and more subsidies for these kind of investments. (Müller 2016) It will be virtually impossible in the current regulatory environment to get the capacities up and running in time before the existing nuclear power plants go off the grid. The main reason for this is that relatively low subsidies are paid for investments in solar and biomass and the low cost of hydropower makes such investments uninteresting. Switzerland being a rather densely populated country, there has also been an important pushback against windparks. For all these reasons, it is unreasonable to believe that these energy sources will be able to pick up the electricity that will be missing due to the exit from nuclear power.

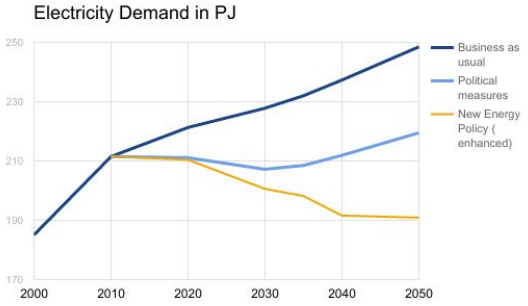


One viable alternative are gas powered plants. Swiss utilities have some experience in this sector but there is no capacity in Switzerland because currently, the technology

economically is not viable compared to water and nuclear energy. Big investments in gas would also pose a problem for Switzerland's CO2 reduction commitments, because even though a pretty clean energy source, gas power plants would still be producing much more carbon dioxide than the nuclear power plants they replace.

The question of dispatchable energy sources is not much of a problem in the Swiss context, because more than one third of electricity comes from dams. It is no problem to adapt energy supply to meet demand with hydro power plants. Swiss utilities even use their dams for economic benefit by using electricity produced when prices are low to pump water into artificial lakes and releasing it into the power plants when rates rise.

Projections (future growth for Business as Usual scenario)



As in most countries, the demand for electricity is set to increase in the coming decades. In the business as usual scenario described in a report prepared by Prognos for the Swiss government, the demand will increase by 17.5% based on 2010 levels. This is lower than the growth of the economy and population. In the second scenario, there is a stabilization of the demand and in the New Energy scenario, the demand decreases by 23% compared to the Business as Usual scenario. This decrease is due to better management of the demand as well as better technologies. (Prognos 2012, 177)

Transportation

Current status and projections

Mobility is important for an advanced economy and has increased significantly in the last decades. Switzerland is no exception. When analyzing transportation, we usually

distinguish between modes of transportation like cars, public transportation (e.g. trains, buses and trams) and air travel as well as between transportation types like private or freight. In summary, all modes and types of transportation have grown in Switzerland in the last two decades. Due to the size of the country and a well developed public transportation infrastructure, the number of cars is 541 cars / 1000 inhabitants, which is significantly lower than for example the United States with 797 cars / 1000 inhabitants. (Hosi and Mittler 2016, 174) Higher income in Switzerland means that people tend to buy bigger, more powerful cars rather than more of them. About 30% of all carbon emissions in Switzerland originate from cars, which is very high in an International comparison. Worldwide, only 14% of emissions come from cars. Another number that illustrates this well is the emission of CO2 per kilometer. In Switzerland, a new car emits an average of 162g, compared to 127g in Portugal. (WWF Schweiz 2017)

Public transportation has increased from 18% (1990) to 20,4% in 2014. (Hosi and Mittler 2016, 176) This shift, coupled with improved mileage standards for cars have had a positive impact on CO2 emissions. Unfortunately, it has been mitigated by the general increase in transportation in the last 30 years.

Transport of freight has grown by a large amount all over Europe. In Switzerland, the volume of freight transported has increased from 20 billion (1990) to 30 billion kilometer tons in 2014. Switzerland has been able to stabilize the amount of freight transported by rail at about 40%, compared to other European countries where this number is dramatically shrinking. This was achieved by a number of regulatory interventions, like a special tax for trucks called “Leistungsabhängige Schwerverkehrsabgabe” (LSVA), and a prohibition on trucks driving at night. (Hosi and Mittler 2016, 176) These regulations, while successful, have not been able to actually reduce emissions because of the growth of freight transportation as a whole, which is very likely to continue in the future.

Developments in aviation are similar to the ones with cars. Technological advances have made engines and aircraft design more efficient, but these improvements have been more than compensated by the overall increase in air travel. This trend is set to continue. Most scenarios project a yearly growth rate for aviation of 5%, while aircraft design will improve efficiency by 2%. This means that any reductions of emissions will be compensated by the increase in air travel.

Current decarbonization plans

Switzerland adopted CO2 reduction legislation in 2011 that instituted gas mileage standards for new cars sold in Switzerland that were to lower consumption by 15% compared to 1990. (Bundeskanzlei-P 2017) The law also attempted to lower overall CO2 emissions by 8%. Unfortunately, these goals have not been achieved yet. Again, the increase in transportation is to blame. The number of kilometres driven in cars has increased from 78 millions (1990) to 95 millions in 2014. (Hosi and Mittler 2016, 176)

Enhanced decarbonization plans

Due to the overall Swiss energy mix, with comparatively low CO2 emissions in electricity generation, it is self evident that it will be crucial to aggressively lower amount of fossil fuels burnt in transportation if Switzerland is to achieve significant reductions at all. Since it seems unlikely that the trend to more mobility is going to end, and because technological possibilities of fuel substitution in aviation are limited, the bulk of that reduction has to come from either a significant increase in electrical vehicles and / or a shift of private to public transportation.

Switzerland already has an extensive and efficient network of public transportation. There will have to be more investments, especially in rural areas as well as linking suburbs and cities to get even more people to use public transportation.

As to electric vehicles (EV), the trends are very promising. Switzerland is a small country, which eliminates one of the main shortcomings of EVs, range. The Swiss also seem to embrace EVs despite their current high prices. The Tesla Model S has been the best selling luxury vehicle in Switzerland for quite some time. ("Tesla Model S Leads Swiss Luxury-Segment In Sales" 2017) Obviously for this trend to make a real difference in carbon emissions, EVs will also have to sell well in lower categories.

During the recent energy debate, the Swiss Federal Council (Swiss government) has floated the idea of enacting legislation that would prohibit the sale of internal combustion engine (ICE) cars by 2040. There has been a lot of debate around this topic and we will see what gets enacted in the coming years, but it seems clear that bold steps are needed to lower carbon emissions in transportation.

Economics/Policy

Current policies that aid or hinder the development of alternative energy sources

Alternative energy sources such as wind, solar and biomass have played a very small role in Switzerland's energy mix. As mentioned earlier, only 4.3% of Swiss electricity is produced with wind and solar energy. There are several reasons for this. First, Switzerland has ample water resources that can cover a large part of its energy needs. Second, and probably partly as a result of the first point, there are almost no subsidies for alternative energy sources and therefore very little incentive for utilities to invest in these technologies. It is telling that most investment done by Swiss utilities in wind and solar have been done in neighboring countries such as Germany, where the subsidies are higher. Germany, whose economy is about 6 times the size of Switzerland's pays out subsidies for renewable energies to the tune of 23.5 bio. Euros compared to only 820

mio Euros in Switzerland. (“Energiewende: Mehr Subventionen Für Erneuerbare Energien” 2013)

Some discussions about the new energy strategy revolve around increasing these subsidies to attract investments. These subsidies, like the ones in effect today, would be financed by an increase of the eco tax on all other energy sources. This is very controversial, because the opponents point out that Switzerland’s electricity production already is very clean and that any new tax would affect the competitiveness of the utilities that operate in an increasingly open market as well as the industry as a whole. (“Energiewende: Mehr Subventionen Für Erneuerbare Energien” 2013)

Projections for changes in key economics and policies

The potential role of cap and trade, carbon taxes, etc. in the region

Switzerland’s overall output per capita is relatively small in comparison to other industrialized nations. In 2011, Switzerland emitted 4.6 metric tons of CO2 per capita, compared to 8.8 metric tons in Germany or 16.8 metric tons in the United States. The main reason for this low number is the virtually carbon free electricity production based on hydro and nuclear power. The main emitters of greenhouse gases are therefore transportation, industry and residential and any incentives would have to be directed at them.

Switzerland has implemented many tools already, with varying levels of success and odds are there will be more to come if the new energy strategy is accepted by Swiss voters. In the area of transportation, about 60% of the price of fuel (gas and diesel) already are comprised of taxes and duties. (Erdölvereinigung 2015) Since 2001, there has been an additional tax on heavy trucks based on performance and distance driven (LSVA). About two thirds of the revenue generated by the LSVA is used directly for

expanding the rail network in Switzerland. The rest is used to maintain road infrastructure. (Are 2017)

The residential sector is another big emitter of carbon dioxide. Switzerland, according to the World Wildlife Fund (WWF), is the biggest consumer of heating oil per head in Europe. (Ruse 2015) To curb emissions from the residential sector, the main tool used by the Swiss government are subsidies. Solar panels, heating pumps and distance heating are all subsidized, even if at a pretty low rate. The efficiency of these tools has been disappointing so far mainly because of the low price of oil.

The third large carbon dioxide producer is industry. In that sector there is a combination of tools that have been used in the past and are likely to be used in the future. First, as mentioned above, there is an eco tax on electricity production that is supposed to finance increased investments in alternative energies. Unfortunately, industries that need a lot of electricity like steel, paper and the chemical industry are exempt from that tax. Switzerland also introduced a cap and trade system in 2009 for carbon dioxide. So far, this effort has borne no fruits. There is almost no active trading going on and the negotiations to integrate the Swiss System into the European Union Emission Trading Scheme (EUETS) has been stalled for years. (Steiner 2014)

Summary

Switzerland is a rather small country with a very limited impact on global climate change. It is also one that due to its topography can use hydropower to cover a large extent of its energy needs and therefore has a comparatively low emission of carbon dioxide per head. Nonetheless, Switzerland, at least in International forums like the UNCCC in Paris has been very vocal in communicating ambitious goals to reduce carbon emissions.

These words have been matched by actions in the sense that Switzerland has introduced a number of legislation to attain these goals, from a carbon tax on energy to a special tax on heavy trucking (LSVA) whose revenues are mainly used to transfer freight from roads to rails, various subsidies to incentivize private homeowners to heat their houses with renewable energies and instituting a cap and trade system for heavy industry.

The thesis of this paper asks whether these goals are ambitious enough to reach the objectives of the Paris Agreement and whether the effectiveness of the planned regulations is sufficient. I fear the answer in both cases is no.

The Paris Agreements, adopted at the UNCCC set a goal for limiting global warming to 2 degrees Celsius compared to pre-industrial levels. The parties also agreed to pursue additional efforts to limit the temperature increase to 1.5 degrees Celsius, which will require zero emissions sometime between 2030 and 2050. (Sutter et al. 2015) Switzerland's commitment to reduce carbon emissions by 50% by 2030 clearly does not meet that goal.

As to the legal framework to implement changes, Switzerland has been very comprehensive and has used a variety of tools. Some of them have worked, others have not had the desired impact. Since the production of electricity is currently based on nuclear and hydro power and therefore almost carbon free, the focus of Switzerland's carbon reduction effort needs to be on transportation, industry and residential energy consumption. Examples of successful regulations are the LSVA which has stabilized the volume of freight transported on rail at 40%, high when compared to other European countries. Gas mileage standards and taxes on cars based on performance and CO2 emissions have also had some effect in the car market. In the residential sector, more and more homeowners decide to invest in renewable energies for heating and even produce their own electricity by installing solar panels.

It is also true that many of these activities have been mitigated by growth. Even if less gasoline is used per mile, the absolute volume of emissions is still increasing or at least decreasing at too slow a rate. The Energy Strategy 2050 being voted on by Swiss citizen on May 21 is a step in the right directions, but it is, in my view, only a first step and the absolute minimum needed to curb the effects of global warming and reach the goals agreed upon in Paris.

Abbreviations

EEA	European Environment Agency
EUETS	European Union Emission Trading Scheme
EV	Electric vehicles
GDP	Gross domestic product
ICE	Internal combustion engine
UNCCC	United Nations Climate Change Conference
WWF	World Wildlife Fund

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