Only PV Can Deliver Enough Power to Decarbonise

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Ladies and Gentlemen,

Today I would like to share with you the political and social impact of my solar plan for Switzerland. I hope that this experience will offer you useful insights helping you to promote solar power in your own country, as well as throughout all of Europe, of course, from which Switzerland has unfortunately excluded itself.

Please let me present myself briefly first. I am elected to the Swiss Parliament and have been a member of the Environment, Spatial Planning and Energy Committee for 15 years. For 10 years now, I have been serving as Swissolar's president, which is the Swiss Solar Energy Professionals Association. I have also been president of the Social-democrat Group in the Swiss Parliament for 5 years.

My first book titled "Libérer la Suisse des énergies fossiles" ("Liberate Switzerland from fossil energies") was published in 2010 and my solar plan "Le plan solaire et climat" ("The Swiss solar and climate plan") was printed in 2019.

1 Starting point

As all civilized countries, Switzerland has adopted the Paris Agreement that will bring about total decarbonization in the long term. We will therefore need more renewable energy sources, especially electricity, in order to replace fossil energies for heating, transport and industry. Naturally, we will have to leverage efficiency increases, which incidentally often result from the changeover to electricity.

In May 2017, via a referendum, Swiss voters adopted a bill banning the construction of new nuclear plants. Therefore, the country will have to replace not only its fossil fuels, but also about 35% of its electricity provided by nuclear plants.

The legislative bill adopted in the 2017 by referendum is limited and will enable to build systems that can cover only half of the power generation that is necessary to replace nuclear production. Nothing was planned for power to replace fossil energy sources.

Therefore, Switzerland needs to be a lot more ambitious in deploying new power sources. This was one of the aims of my approach; the other was to show that solar power is able to cover most of our needs.

2 Specific circumstances

Some specificities of Switzerland's situation need to be explained in order to help you understand my approach.

Three specific problems characterise the situation in Switzerland:

1) Wind power and biomass potentials are relatively restricted due to the small size of our territory.
2) Because of melting snows, run-of-river power production is higher at the end of spring and during summer. In contrast, electricity consumption is higher in winter due to heating needs.
3) Hydropower was a historical pillar of power generation but has almost used up its potential.

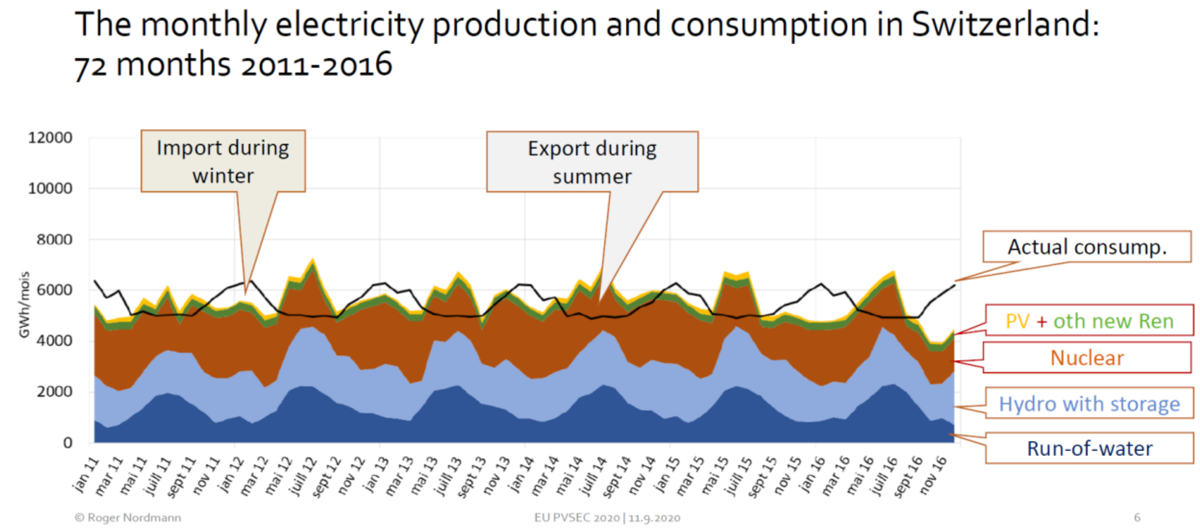
However, the Swiss situation also features two opportunities:

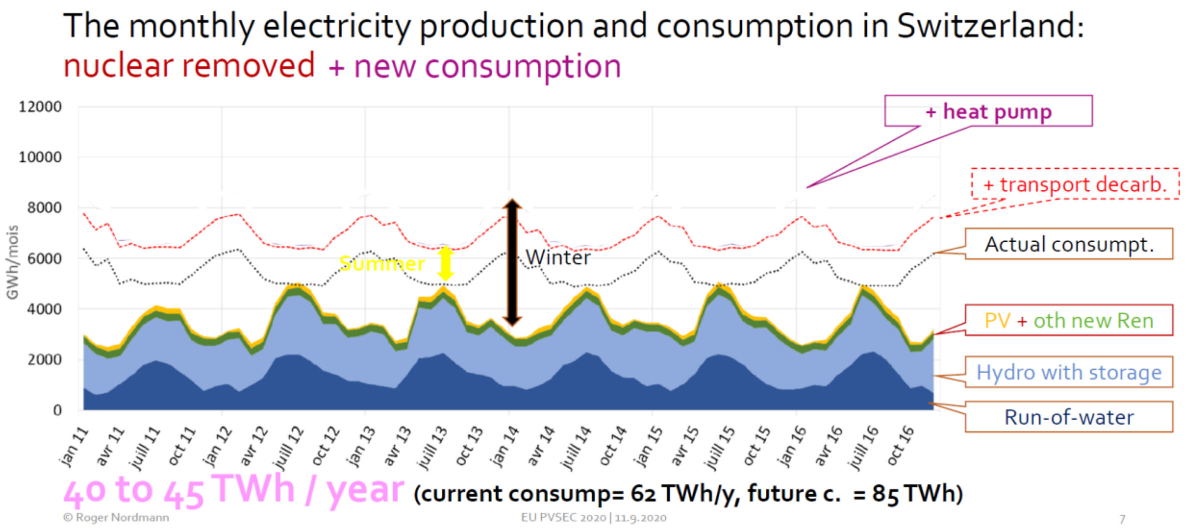
- The PV rooftop potential is very high. This is mainly due to good solar exposure and altitude. The technology is very well accepted. During the last 10 years, 60% of additional power generation was provided by photovoltaics.
- Half of our hydropower capacities have accumulation reservoirs that can be used flexibly. Many of them not only have turbines, but also pumps. These enable them to store excess electricity by pumping water back into the dams. Switzerland has a power storage capacity of 1000 kWh per capita and a pumping capacity of 0.5 kW/capita. Additional short-run storage (day/night, week) is no problem.

However, this storage capacity is already used to the maximum for balancing summer and winter differences.

3 The challenge of power generation

I had to take a head-on approach in order to help everyone to understand the scope of the challenge of our power demand and of the load balancing between summer and winter. I decided to represent the development of our situation in a diagram, based on monthly data from 2011 to 2016.
I removed nuclear production and added the power demand enabling to replace fossil energies.





Now everyone understands the extent of Switzerland's challenges. All in all, we will need about 85 terawatt-hours annually. Without nuclear plants, today's capacities are able to cover only half of this. We need to add 40 to 45 TWh of electricity every year. In addition, demand is much higher in winter than in summer.

4 A reversal of paradigms: only PV has enough potential

Against potential expectations, this diagram showing how high our demand is and emphasizing our problem in winter has not prevented me from promoting solar power. On the contrary, I used it to lay the foundations for my approach. By daring to name the problem, our credibility has increased. A broad consensus is now established that we need to invest massively in power production (not only using PV).

Through out-of-the-box thinking, I concluded that quantitatively speaking, only PV has the power to deliver and to cover our additional demand. Solar potential in Switzerland is 120 GW, half of which lies on buildings (rooftops and facades). This is more than enough to produce the 40 or 45 TWh we need.

Claiming that this should be PV's role was a Copernican reversal of paradigms. Solar would no longer remain a small backup source, but become a main pillar of power supply (together with hydropower).

To get there, I had to overcome technical objections, but also traditional lines of argumentation and prejudices, which are often mixed.

Before addressing our opponents' objections, I began by sweeping away our own prejudices. Environmental circles had to be convinced that efficiency increases would not be enough. We will need a lot more additional electricity and it will become our main energy source (this is a disruptive approach because ecologists like to criticize electricity due to its production-related ecological nuisances).

Technically, two issues had to be solved in the specific Swiss context:

- What can be done to achieve a production able to provide enough energy during the winter months?
- How can the grid be managed so it can cope with possible momentary overproductions and significant capacity deficits due to high PV input?

5 My basic scenario

To find answers, I calculated a simple, robust basic scenario based on the following assumptions:

- Consumption to meet current power needs remains stable, because efficiency increases offset demographic and economic growth.
- Consumption of electrified mobility on land and of additional thermal pumps is added to current consumption. In other words, we have the assumptions of zero fuel consumption (petrol, diesel, heating oil and gas) for mobility, heating and hot water.
- Only solar power expands massively. All the other renewable energies stagnate.
- Power-to-gas can use a maximum of one terawatt-hour each summer month. The gas output is used for power generation during the following winter, but its efficiency is only 30% (comparison of electricity output and input).
- In monthly values, Switzerland does not export more power in summer than today and does not import more electricity in winter than now.
- No massive expansion/reinforcing of the grid.

Based on these assumptions, I suggested to add 50 GW of solar power in Switzerland, which is the equivalent of approximately 6 kW per capita. This is 25 times more than we had in 2018. Once this changeover will be accomplished, solar production will exceed hydropower.

6 Peak shaving and gas

By suggesting this, I risked posing as an extremist. But I was able to defuse this perception by including two technological answers into my model right from the start.

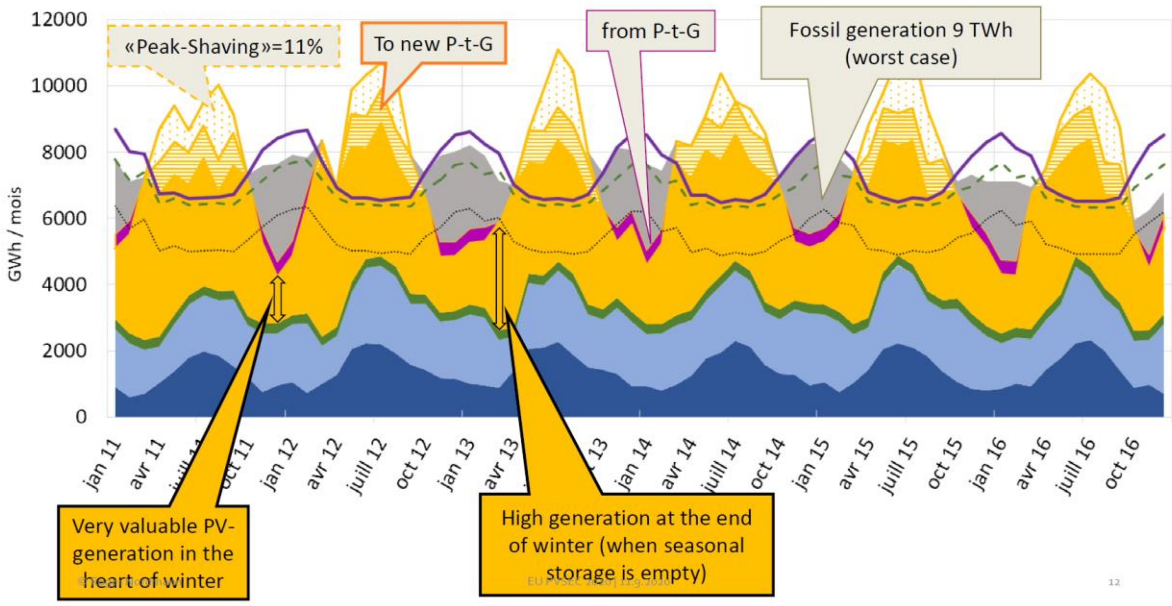
- When PV production exceeds the absorbing capacity of the grid or when there is temporarily a lot more energy than needed, the feed-in quantities into the grid are reduced by "peak shaving" (curtailment). Feed-in is adjusted in real time. As we will see, this solution costs almost nothing.
- The second suggestion is to expect having to use fossil gas to produce electricity in case of shortage in wintertime. This solution won't surprise you, but it was considered a taboo in Switzerland, for we have next to no fossil gas production. Naturally, since it will be produced in winter, excess heat can be used to cover heating needs through a cogeneration approach.

7 Peak shaving helps throughout the winter

By balancing the annual power production curve, peak shaving allows us to feed a lot more PV power into the grid. The financial losses incurred are limited, since peak shaving is done when electricity is cheapest because it is available in excess on the market. This is why peak shaving appears to be acceptable or even economically attractive to us while it still protects the price of the kilowatthour.

8 Results in the basic scenario

The next diagram shows the hypothetical situation for the years 2011 to 2016 with 50 GW of PV installed, and of course a complete decarbonization of the buildings and the mobility on land. This is my basic scenario.



Finally, it's this diagram that has made political circles move:

- It shows that peak shaving and secondarily power-to-gas can enable Switzerland to install enormous solar power capacities.
- With peak shaving, only 11% of potential solar power generation may be lost.
- Solar can provide a valuable base in winter through the massive addition of PV that will now be possible.
- At the end of winter, when the storage dams are empty, PV can already deliver a significant power output.

9 The CO_2 balance sheet of the basic scenario

Daring to formulate head-on the deficiency problem during the winter has significantly increased my credibility. Naturally, some media and old pronuclear parties tried to attack me based on the emissions of fossil gas production because I suggested using gas as a worst-case option. However, the overall CO_2 balance of my strategy is very good: it enables to reduce CO_2 emissions by 86% in the relevant perimeter. That's why critical comments have had almost no response.

= 3/5 of overall Swiss GHG Emissions

Million tons CO_2	2017	Full decarb (off-) road and buildings
(off-) Road	16	0
Buildings	14.8	0
Fossil power Generation	0	4.4
Total	**30.8**	**4.4**
Decrease CO_2		-86%

I think I was able to open many doors because I honestly revealed the extent and nature of the challenge. In the last few months, almost all of the political circles and most of the stakeholders have acknowledged that an enormous amount of solar will be needed. Naturally, some consider 50 GW too much and claim that 30 GW will be enough. But since we have achieved 2.5 GW today and the same circles used to say that to have 5 or 10 GW was impossible, I am happy with the way the discussion evolves.

10 My scenario is basic, not an optimum

You may object that my scenario is not up-to-date, that all of the excess kilowatt-hours could be used through a massive expansion of power-to-gas. And that this renewable gas could cover the winter deficit, even if this meant having to add more than 50 GW. Or that other solutions might be taken into account for long-term storage, such as heat storage tanks or regenerating geothermal probes in the summer.

From a technological point of view, you are absolutely right.

From an economic viewpoint, it's useful to calculate a trade-off. Production losses incurred by peak shaving sketch a kind of baseline that is feasible and inexpensive. However, there's no objections to improving things as long as it's economically reasonable.

It's on a political level that my basic scenario has had a decisive effect: even the most conservative circles, such as companies wanting to keep nuclear plants going for another 30 years, have realized that it's technically feasible. The timing was good: when their nuclear dreams were shattered in 2017 due to the referendum, they needed to find a different solution. They were compelled to stop sulking in their corner one day…

Finally, choosing a basic and conservative scenario rather than a scenario involving cutting-edge technology has enabled everyone to debate on how to optimise it…

And the burden of proof has changed sides to a certain extent. Now PV opponents have to prove they have a plausible scenario. In fact, they don't, unless they want to promote imported electricity or resuscitate nuclear power…

My head-on approach (with 50 GW) also contributed to drive the discussion on how to finance future investments in power generation. While large firms pretended to compensate all the investments via the open market thanks to the "energy-only market", the discussion has now gone much deeper and the gridlock has become apparent to everyone. Today we are discussing the details of extending investment aids for renewable energies. Some prefer calls for tenders for kilowatt-hours, while others would rather want one-off contributions to investments.

11 Learnings from this approach

To conclude, I would like to highlight some of the features of my approach that have given it credit beyond technical solutions. This kind of attitude seems to be able to trigger positive developments in any country. I tend to classify my approach into three categories: diagnostic, proposition and persuasion.

Naturally, the approach can't be copied as is from a technical perspective. Every country has its own assets (for example wind power in winter) and challenges (for example missing storage options). It's rather the mindset that can be duplicated.

1) *The diagnostic phase*

A) The phase during which the problems are identified is crucial. It takes a lot of time and imagination. It's not only about listing data, but about structuring them in hierarchies.

B) This means that in highly complex systems such as energy, a situation analysis should concentrate on the main challenges in order to be well outlined and leave aside thousands of secondary issues that cloud the picture and induce immobility.

C) It is essential for the diagnostic to include the cultural state of the debate. The way experts and public opinion consider the challenges is just as important as the technical challenges themselves. Before starting to create solutions, we need to achieve a good grasp of the images and paradigms that prevail in political circles and fellow citizens.

2) *The proposition phase*

D) A plan must not only trace a path, but also eliminate obstacles. Among these hurdles, we should not overlook our own prejudices and those of our best allies.

E) A good proposition does not disregard the most inconvenient issues, but tries to address them honestly. Minimizing problems or oppositions is not useful. However, making the best use of the plan as a driving force for society globally will be fruitful.

F) A good plan is based on solid, well-documented and, most importantly, cautious facts instead of exaggerated optimism. It has to resist the roughest assumptions and will get more credit if the chosen starting parameters are less favourable.

3) *The persuasion phase*

G) Convincing people is not only done by accumulating arguments, figures and diagrams and overwhelming your counterpart with relentless and skilful demonstrations. It's also about getting opposing minds to move by asking fundamental questions and inviting them to find their own solution. In your opinion, is there a different, less expensive solution? Our plan must be set up to allow for this strategy.

H) Don't be afraid to enter your opponents' ground, not by being subservient to their thinking, but by showing them a path that takes their interests into account. Help them to come out of the track of their traditional reasoning and open an exit for them.

I) Finally, keep in mind that the concept of energy opens up a huge range of meanings and representations, some contradictory, in our fellow citizens' minds. Starting from hard sciences such as maths and physics, it covers the entire field of technology, but also touches psychology, health, way of life, etc.

Is it possible that a solar plan – if it is technically operational and politically credible – can also bring about a new way of living together?

Reference book + E-book:

French: https://www.editionsfavre.com/livres/le-plan-solaire-et-climat/

German: https://www.zytglogge.ch/sonne-fuer-klimatschutz-solarplan-solarenergie-sonnenenergie-roger-nordmann

Further infos: https://rogernordmann.ch/livre-le-plan-solaire-et-climat/