The future of nuclear power in Switzerland

Wolfgang Denk, Head of Nuclear Assets, Alpiq Suisse SA
Platts European Nuclear Power Conference, Budapest, 1 July 2014
Electricity Flow Diagram Switzerland 2013

Input

Other: 3.9 TWh
Nuclear: 24.9 TWh
Run of river: 17.8 TWh
Storage hydro: 19.7 TWh

Net Imports: 36.2 TWh

Source: Swiss Electricity Statistics 2013, SFOE
Electricity Flow Diagram Switzerland 2013

Output

Net Exports 38.6 TWh

Households Agriculture Industry Services Transport
18.8 TWh 1.0 TWh 18.8 TWh 16.0 TWh 4.8 TWh

Source: Swiss Electricity Statistics 2013, SFOE
Daily generation profiles 2013
Spring, Summer, Fall, Winter

Source: Swiss Electricity Statistics 2013, SFOE
# Domestic Nuclear and Long Term Contracts

Suppling Switzerland with 42 TWh Electricity

<table>
<thead>
<tr>
<th>COD Foundation</th>
<th>Plant/LTC Capacity</th>
<th>Generation/Import 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swiss units</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beznau 1&amp;2</td>
<td>1969/1971</td>
<td>730 MW</td>
</tr>
<tr>
<td>Mühleberg</td>
<td>1971</td>
<td>373 MW</td>
</tr>
<tr>
<td>Gösgen</td>
<td>1979</td>
<td>1010 MW</td>
</tr>
<tr>
<td>Leibstadt</td>
<td>1984</td>
<td>1220 MW</td>
</tr>
</tbody>
</table>

| **Nuclear imports (LTC from France)** | |
| CNP (FES, CAT) | 1972/1985          | 830 MW                 | 5.1 TWh |
| AKEB (BUG, CAT) | 1972/1984        | 521 MW                 | 2.9 TWh |
| ENAG (-)       | 1990              | 400 MW                 | 3.5 TWh |
| Others         | ~1000 MW          | ~5.5 TWh               |        |

**Total for Switzerland 2013: 42 TWh**
(Total domestic consumption: 64 TWh)

Sources: SFOE, annual reports, internal sources ("Others")
Hydroelectric Power & Nuclear Power
A “winning team” for Switzerland
Status quo in Switzerland

- Massively reduced electricity market prices in Western Europe triggered to a large part by German politics (in 2013, Germany pumped 24 bn EUR in subsidies into a 30 bn EUR «market»)
- Large investments in existing nuclear plants ongoing (mid of life & continuous safety improvements)
The future of nuclear power in Switzerland
Possible scenarios

1) NPPs shut-down after 45 y life-time (Green party referendum)
2) Zero nuclear power by ~2034 (~50 y Gösgen & Leibstadt)
3) Zero nuclear power by ~2044 (~60 y Gösgen & Leibstadt)
4) Gösgen and Leibstadt to operate beyond 2039/2044
5) Nuclear new build projects to restart soon
Energy strategy 2050 in Switzerland
The outline

- Nuclear plants not to be replaced by new ones, but existing units to continue to operate
- More «new» renewables in Switzerland (>10 TWh Solar PV? >4 TWh Wind? Geothermal power?)
- Massive deployment of energy efficiency measures
- 3-6 CCGT units in Switzerland might be necessary (Prognos Study commissioned by Federal Office of Energy)
- High import dependency is probable (French nuclear? German fossil?)

«Total system change»
Swiss Newspaper NZZ of 5 May 2014: Latest article on the Swiss Energy Strategy

Challenges mentioned:
• Need for storage and grid reserves to cope with “growing volatility of generation due to renewables”
• “Market distortions in the EU through high subsidies and over-capacity”

Not mentioned:
• Reason for shutting down nuclear power
• Replacement of >40% of annual supply
“Security of supply is possible, if we lose our illusionary precondition of autarky”
→ Dependency on others for Swiss security of supply

Increase in own subsidy for renewables (KEV)
→ Consumers to cover higher costs

“Keep an eye on developments in fracking”
→ Accept increase in fossil fuels (& prepare population for need of CCGT plants?)
A word on hydraulic fracturing
How desperate are we?

Conventional tobacco source

Unconventional tobacco source
Swiss Newspaper NZZ of 5 May 2014: “Solutions” proposed (2/2)

- “Need for international “intelligence” for the optimization and interconnection of generation, transport and consumption, while taking into account volatile electricity generation and the increasingly volatile prices on the electricity markets via a comprehensive implementation and integration of global IT resources”

→ Hoping that “intelligence” and “global IT” will help solve the problem
Swiss energy transition flow chart
It’s complicated...

- Fukushima cores melt
- NPPs “explode”
- Population evacuated
- Low “market” prices
- Sun & Wind are “free”
- Green is trendy
- EU
- Germany

**Nuclear too risky**

**Total system change**

**Generation & distribution**
- Find a solution for intermittent wind & solar
- Massively expand grid connections
- “Cultural change” in electricity utilities

**Technology**
- Find new revolutionary battery technology
- Support new technologies (but not nuclear)
- Include more IT (?)

**Consumer behaviour**
- New grids with smart technology
- No longer “on-demand”, but “on-supply”
- Reduce consumption

**Funding system**
- Keep hydropower competitive
- Increase prices & redistribute funds
- Keep market-based approach

**Eco-friendliness**
- Avoid fossil fuel fired plants
- Support wind, solar, geothermal and others?
- Massively expand efficiency measures
Fraunhofer Institute simulation for Germany
100 % renewables for electricity and heat

Diagram: Fraunhofer ISE 12 November 2012
### Demand → significant reduction

- **Heat:** 65% of 2010 values (total heat consumption: 625 TWh)
- **Electricity:** 80% of 2010 values (total electricity consumption: 500 TWh)

### Supply → completely new system

#### Electricity & heat (centralized)

<table>
<thead>
<tr>
<th>Source</th>
<th>Capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>252</td>
</tr>
<tr>
<td>Wind onshore</td>
<td>200</td>
</tr>
<tr>
<td>Wind offshore</td>
<td>85</td>
</tr>
<tr>
<td>CCGT</td>
<td>81</td>
</tr>
<tr>
<td>Power-to-Gas</td>
<td>88</td>
</tr>
<tr>
<td>Power and heat</td>
<td>13</td>
</tr>
<tr>
<td>Solar thermal plants</td>
<td>32</td>
</tr>
</tbody>
</table>

#### Electricity, heat & storage (decentralized)

<table>
<thead>
<tr>
<th>Source</th>
<th>Capacity (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric heat pump systems</td>
<td>140</td>
</tr>
<tr>
<td>Solar thermal (roof top)</td>
<td>85</td>
</tr>
<tr>
<td>Heat storage</td>
<td>246 GWh</td>
</tr>
<tr>
<td>Gas heat pump systems</td>
<td>107</td>
</tr>
<tr>
<td>Solar thermal (roof top)</td>
<td>65</td>
</tr>
<tr>
<td>Heat storage</td>
<td>62 GWh</td>
</tr>
</tbody>
</table>

#### Storage and other heat generation (centralized)

<table>
<thead>
<tr>
<th>Source</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane storage</td>
<td>86 TWh</td>
</tr>
<tr>
<td>Centralized Battery storage</td>
<td>52 GWh</td>
</tr>
<tr>
<td>Pumped storage</td>
<td>60 GWh</td>
</tr>
<tr>
<td>Centralized Heat Storage</td>
<td>47 Mio. m³</td>
</tr>
<tr>
<td>Biomass</td>
<td>50 TWh</td>
</tr>
</tbody>
</table>
100% Renewable electricity generation
A highly inefficient system

- **252 GW Solar PV**
- **285 GW Wind**
- **81 GW CCGT**

- Energy Transformation System
- Storage System
- Grid & Distribution System

~ 80 GW peak demand
Personal thoughts:
How about keeping it simple?

WEC 2013: Switzerland “best in the world”

Maybe the “old” system is not so bad?

Why not keep the system and further improve it?
If it ain't broke, don't fix it!

Bert Lance (1931-2013), Director of the Office of Management and Budget under President Jimmy Carter in 1977:

“That's the trouble with government: Fixing things that aren't broken and not fixing things that are broken.”

Thank you very much!

Wolfgang Denk, phone +41 79 571 39 64
wolfgang.denk@alpiq.com