

Swiss Electricity Supply Options

**A supplementary paper for PSI's Energie Spiegel Nr. 21
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Table of Contents

1. Background	3
2. Definition of electricity supply variants.....	5
3. Results	7
3.1. Notes on result parameters.....	7
3.1.1. Electricity supply.....	7
3.1.2. Electricity system cost	8
3.1.3. CO₂ emissions	9
3.1.4. Generation schedule.....	9
3.2. Electricity generation mix	10
3.3. Capacity expansion	12
3.4. Emissions and costs	12
3.5. Electricity generation schedule.....	17
4. References	20
Appendixes	i

List of Figures

Figure 1: Swiss electricity demand forecasts	3
Figure 2: Review summary of electricity supply mix in 2050.....	4
Figure 3: Electricity generation mix and installed capacity in 2050.....	11
Figure 4: Cumulative capacity additions during 2013 – 2055	12
Figure 5: Annual CO ₂ emissions in 2050	13
Figure 6: Undiscounted electricity system cost in 2050	14
Figure 7: Average electricity cost in 2050	15
Figure 8: Cumulative (2013 -2055) cost of electricity system costs.....	16
Figure 9: Electricity generation schedule on weekdays - <i>P-Gas</i>	18
Figure 10: Electricity generation schedule on weekdays - <i>P-Imp</i>	19

List of Tables

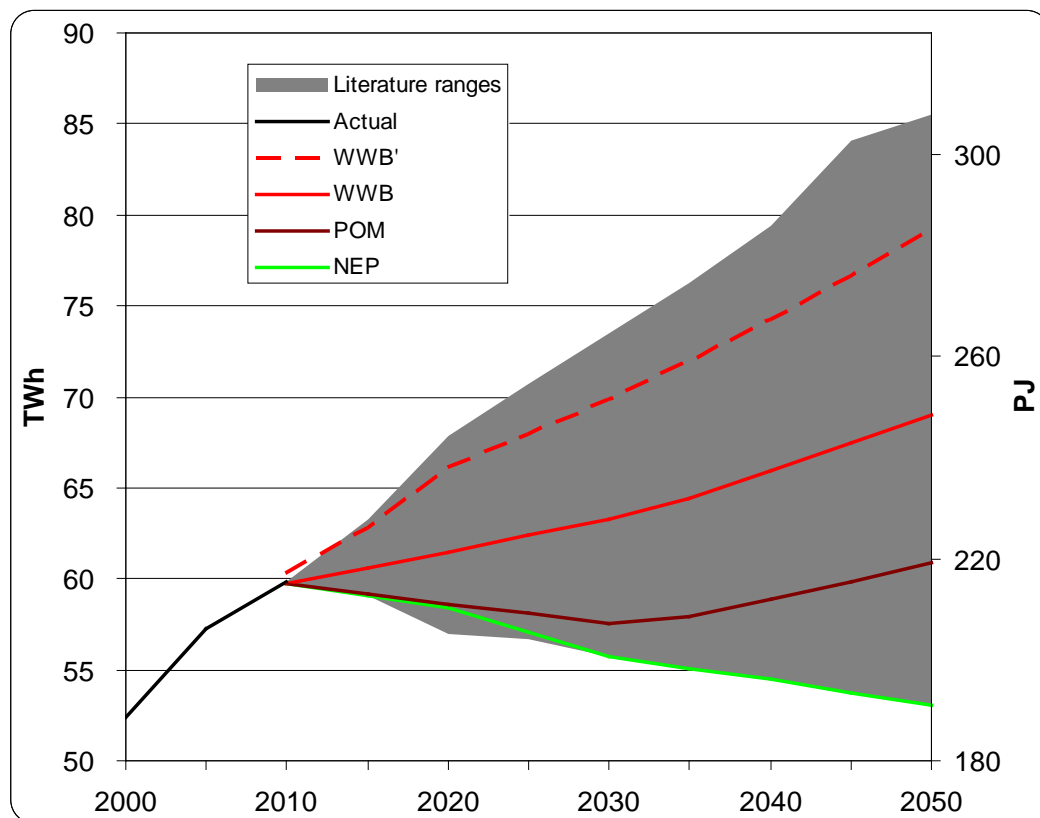
Table 1: Description of electricity supply variants	6
Table 2: Result reporting years and their periods	7

List of Appendixes

Appendix I: POM demand and gas based electricity supply (<i>P-Gas</i>)	1
Appendix II: POM demand and import/renewable electricity supply (<i>P-Imp</i>)	7
Appendix III: POM demand and nuclear electricity supply (<i>P-Ref</i>)	13
Appendix IV: NEP demand and gas based electricity supply (<i>N-Gas</i>)	19
Appendix V: NEP demand and import/renewable electricity supply (<i>N-Imp</i>)	25
Appendix VI: NEP demand and nuclear electricity supply (<i>N-Ref</i>)	31
Appendix VII: WWB demand and gas based electricity supply (<i>W-Gas</i>)	37
Appendix VIII: WWB demand and import/renewable electricity supply (<i>W-Imp</i>)	43
Appendix IX: WWB demand and nuclear electricity supply (<i>W-Ref</i>)	49
Appendix X: POM demand and gas based electricity supply with winter security (<i>P-Gas-S-win</i>)	55
Appendix XI: POM demand and gas based electricity supply with security (<i>P-Gas-S</i>)	61
Appendix XII: POM demand and nuclear electricity supply with security (<i>P-Ref-S</i>)	67
Appendix XIII: NEP demand and gas based electricity supply with winter security (<i>N-Gas-S-win</i>)	73
Appendix XIV: NEP demand and gas based electricity supply with supply security (<i>N-Gas-S</i>)	79
Appendix XV: WWB demand and gas electricity based supply with supply security (<i>W-Gas-S</i>)	85

1. Background

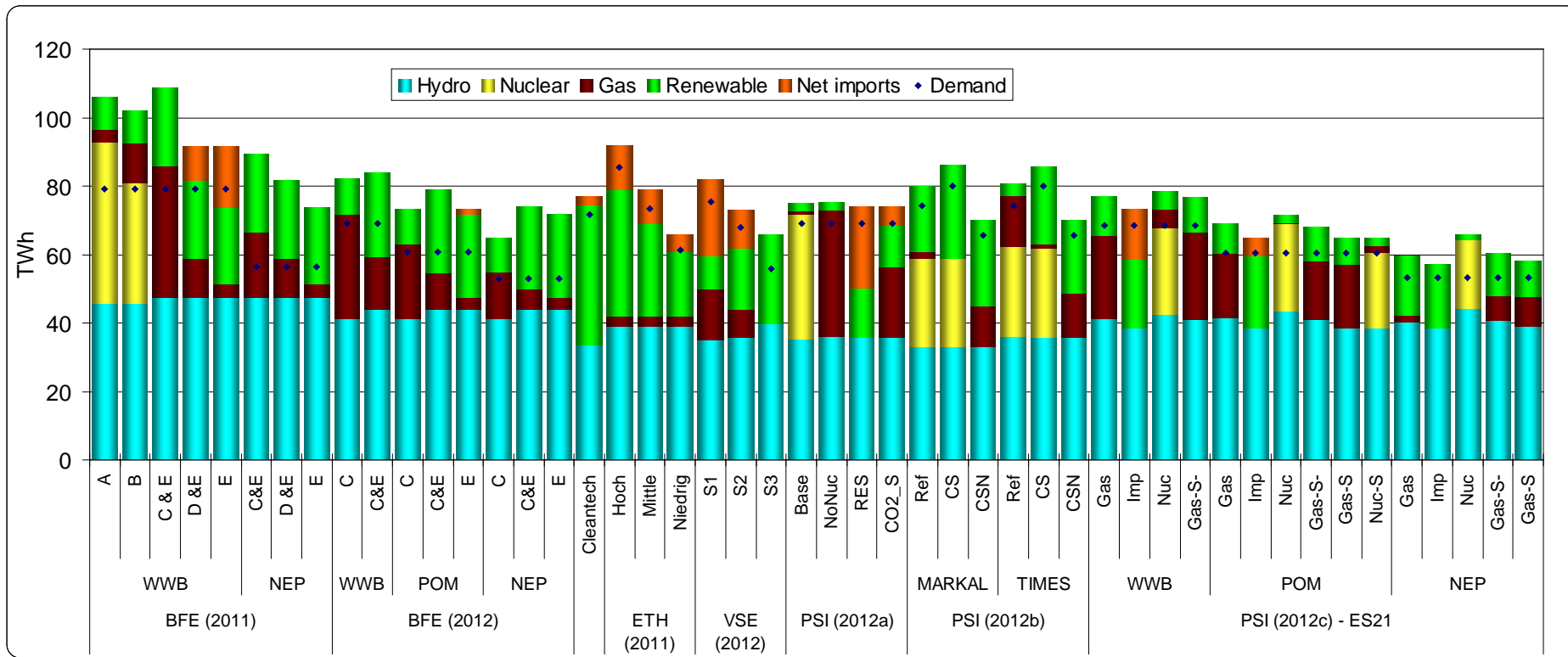
Since the Swiss Federal Council's decision to gradually phase out nuclear energy by 2034 [8], future options for electricity supply have been discussed and highly debated. In May 2011, the Swiss Federal Office of Energy (SFOE) published a preliminary report on the 2050 Swiss Energy Strategy [2] with two energy scenarios – Weiter Wie Bisher (*WWB*) (i.e. Business as usual) and Neue Energiepolitik (*NEP*) (i.e. New Energy Policy). This was followed in September 2012 with a consultation document [3] presenting three revised scenarios—*WWB*, *NEP* and Politische Massnahmen (*POM*) (i.e., Policy Measures). The *POM* scenario incorporates a broad package of energy efficiency measures to reduce energy and electricity demands, many of which were first announced in April 2012 [4]. Figure 1 shows the three electricity demand scenarios¹ from the government's consultation document [3] and other demand projections (shaded areas) from various other studies [1][2][7][14][16][17][18][19][20] that have analysed future electricity supply options (Figure 2).



The *WWB*, *NEP* and *POM* are demand projections from BFE [3] in September 2012 and the *WWB'* is from May 2011 [2]. The shaded area shows demand range from various other studies [1][2][7][14][16][17][18][19][20].

Figure 1: Swiss electricity demand forecasts

¹ The basic assumptions on energy demand drivers (i.e. population, economic growth, housing stock, floor area, and transport demand) are same in all three scenarios.



Sources: BFE (2011) [2]; BFE (2012) [3]; Cleantech [18]; ETH (2011) [7]; VSE (2012) [19]; PSI (2012a) [20]; PSI (2012b) [10]; PSI (2012c)- ES21 [15]

Figure 2: Review summary of electricity supply mix in 2050

In this paper, we present a set of results from the analysis of electricity supply options for the government's three electricity demands in Figure 1 using the Swiss TIMES² Electricity Model (STEM-E).

The Swiss TIMES Electricity Model (STEM-E) was developed at PSI. The key features and strengths of STEM-E include its cost-optimization³ approach; long time horizon (2000-2100) to deal with long-lived technologies; representation of variations in electricity demand and supply at an hourly⁴ level; and detailed characterisation of technologies. Most importantly, the TIMES modelling framework is well documented [13], and the structure, input data and assumptions of STEM-E are transparent [9][11]. A number of electricity supply scenarios have previously been analysed with STEM-E [20][10][12]. For the current analysis, some of the model assumptions and input data have been changed/updated as described in the supplementary model documentation [11]. In *Energy Spiegel* Nr 21 (*ES21*) [15], selected results from this analysis are published. This paper presents additional analytical results. We present only numerical results with highlights on insights, since the underlying drivers are well explained and discussed in our earlier publications [10][20]. The model results should be interpreted in the context of model inputs and limitations (see in [10][20][15]).

2. Definition of electricity supply variants

For each of the three electricity demand pathways published by the SFOE, we analysed three core electricity supply options based around: natural gas (*Gas*); renewables/imports (*Imp*); or nuclear⁵ generation (*Nuc/Ref*). In combination with the core supply variants, two ad-hoc variants of electricity supply security were analysed, in which electricity demand is supplied only from domestic generation, instead of imported electricity. The electricity supply variants are described in Table 1. The three electricity demands, i.e. *WWB*, *POM* and *NEP* are denoted with a prefix *W*-, *P*- and *N*- respectively. A discount rate of 2.5% is used for this analysis. Parametric sensitivities on technology cost assumptions and discount rates are performed in our earlier publication [10].

² TIMES is a technology rich, least-cost optimization modelling framework developed by the Energy Technology Systems Analysis Program (ETSAP) of the International Energy Agency. The TIMES analytical framework is well-established and has been extensively used by many national governments and international organizations (e.g. IEA's biennial Energy Technology Perspectives).

³ The electricity supply, including investment decisions, is optimized (i.e., total discounted electricity system costs are minimized) for the entire time horizon.

⁴ The 8760 hours of the year are represented in 288 hourly time steps with four seasonal (winter, spring, summer and fall) and three daily (weekdays, Saturdays and Sundays) levels of disaggregation.

⁵ This supply variant may be viewed as reflecting the policy situation prior to the Council's May 2011 decision [8] to phase out nuclear generation.

Table 1: Description of electricity supply variants

Electricity supply variants	Description of supply variants	Electricity demand		
		WWB	POM	NEP
1. Gas (-Gas)	<ol style="list-style-type: none"> Continuous operation of the existing nuclear power plants until the end their 50 year operational lifetimes. New investment in the following power plants is possible: <ol style="list-style-type: none"> Gas combined cycle plant (GTCC) (unit size of 550 MW) Gas combined heat and power generation (CHP) plants Renewable electricity generation technologies, including refurbishment of existing hydro power plants, up to their resource potentials (see Table 4 in [11]) Electricity trade** is enabled. However, a “self-sufficiency constraint” is imposed from 2015 requiring that net electricity trade is roughly in balance over the year. The timing of electricity trade is left unconstrained, but annual exports and imports are required to be roughly in balance. 	<i>W-Gas</i>	<i>P-Gas</i>	<i>N-Gas</i>
2. Renewable /Imports (-Imp)	<ol style="list-style-type: none"> Same as the <i>Gas</i>-based electricity supply variant but investment in gas plant (both GTCC and CHP) are fully restricted. The assumption that electricity trade must be in balance over the year is now relaxed thereby enabling <i>net</i> import of electricity to meet any shortfall from domestic supply, i.e. level of net import varies by the demand scenario 	<i>W-Imp</i>	<i>P-Imp</i>	<i>N-Imp</i>
3. Nuclear/ Reference (-Nuc/Ref)	<ol style="list-style-type: none"> Same as the <i>Gas</i>-based electricity supply variant but investment in new nuclear plant is enabled (unit size of 1 GW). (This supply variant may be viewed as reflecting the policy situation prior to the Council’s May 2011 decision [8] to phase out nuclear generation) 	<i>W-Ref</i>	<i>P-Ref</i>	<i>N-Ref</i>
Supply security variants (-S)	An additional constraint that fully restricts electricity trade . Thus variations in seasonal demand and supply are balanced with domestic generation capacity. The security (-S) variants is applied to the supply variants above.		<i>P-Gas-S</i> <i>P-Ref-S</i>	<i>N-Gas-S</i>
Supply security variants for winter (-S-win)	Similar to the supply security variant (-S) but the constraint is applied only in the winter season.	<i>W-Gas-S-win</i>	<i>P-Gas-S-win</i>	<i>N-Gas-S-win</i>

* The supply variants *Gas*, *Imp* and *Nuc/Ref* can be compared to the Swiss Energy Strategy [2][3] electricity supply variants C, E and A/B, respectively. However, STEM-E scenarios are cost optimised.

** It is assumed that there would be a market for importing and exporting electricity at the given cost assumption (see [9][11]). However, there are many uncertainties in future markets, which highly depend on the development of energy policies in neighbouring countries and the EU.

3. Results

The model outputs include: electricity generation mix by fuel and technology; primary fuel demands; costs (investment, fuel, operation and maintenance of technologies and infrastructures); and CO₂ emissions. In this section we present key metrics from all supply variants in Table 1 for the year 2050. Metrics for each future time period for each of the supply variants are given in the Appendix. Each time period is labelled according to the middle year (or milestone year) in the period (see Table 2). Importantly, this milestone year represents an average of the entire period, rather than the specific year (e.g. 2020 represents 2018-22; 2048: 2041-55).

Table 2: Result reporting years and their periods

Actual time periods	Milestone year
2000 - 2000	2000
2001 - 2002	2001
2003 - 2004	2003
2005 - 2006	2005
2007 - 2008	2007
2009 - 2012	2010
2013 - 2017	2015
2018 - 2022	2020
2023 - 2028	2025
2029 - 2040	2034
2041 - 2055	2048
2056 - 2070	2063
2071 - 2090	2080
2091 - 2110	2100

3.1. Notes on result parameters

The following are the key metrics presented:

3.1.1. Electricity supply

Total electricity supply is aggregated by energy resources/technologies such as hydro, nuclear, gas and renewables.

The hydro category includes electricity generation from run-of-river hydro (Hydro (R)), reservoir/dam storage hydro (Hydro (D)) and pumped storage hydro (Hydro (P)). Electricity consumption of pumped storage is reported separately as "Pumps". Output from pumped storage hydro is 80% of its input, i.e. 'Pumps'.

Gas (Base) and Gas (Flex) refer to base-load and flexible gas combined cycle plants respectively. Electricity outputs from natural gas based CHP are reported as Gas (CHP).

The renewable category includes geothermal, solar (PV), wind, waste (which includes waste incineration and waste gasification technologies) and woody biomass.

The self-sufficiency constraint is applied in all supply variants except for the *-Imp* supply variants. Thus, for the *Imp* supply variants (e.g. *W-Imp*, *P-Imp*) net imports are reported.

Demand is also shown in the supply mix plot, representing the end-user demand excluding T&D losses and electricity used in pumped hydro plants. Total electricity demand in the system includes end-use demands (as in Figure 1), T&D losses (~7%) and energy used for pumps, if any. The total supply balances the total demands at the hourly level.

3.1.2. Electricity system cost

Costs are broken down into the following categories:

- *Capital* costs cover the annuities on investment costs from all technologies in the system. It also includes the annuity from existing⁶ hydro and nuclear power plants (see [11] for detail).
- *Fixed O&M* costs are the total fixed operation and maintenance (O&M) costs from all technologies in the system.
- *Variable O&M* costs are the total variable O&M costs of all technologies. However, the *variable O&M* cost does not include fuel costs.
- *Fuel* costs comprise the total cost of all energy resources, including nuclear fuel. The fuel cost does not include the cost of imported electricity, which is reported in the “trade balance” category.
- *Taxes/levy* includes the CO₂ tax, nuclear waste disposal and decommissioning levy, and the electricity surcharge imposed on end-users. Revenue from taxes is not recycled.

⁶ For the existing hydro and nuclear power plants (see Table 4 in [9] for the existing capacity of hydro and §4.1.2 for nuclear) the annuity is included in the model. The annuity of hydro plants is based on the estimated refurbishment costs (Table 3 in [9]) with 80 years life and a discount rate of 2.5%. For all existing nuclear plants, the annuity is estimated with a capital cost of 3500 CHF/kW, 50 years lifetime and 2.5% discount rate. The annuity cost is estimated only for the remaining capacity in each period.

- *Trade balance* refers to the net cost from electricity trade. It is the total cost of imported electricity minus revenue from exported electricity. Even though the annual volume of net import/export is balanced (though the self-sufficiency constraint), the variations in import and export prices may lead to a positive or negative electricity trade balance. Capital and O&M costs of interconnectors are not included in the *trade balance* category. They are reported under the above costs categories (i.e. in Capital and O&M costs).
- *Heat credit* refers net revenue from a heat credit⁷ applied for heat outputs from CHPs (see [11] for detail).

The costs are also presented by technology categories. In this case, fuel, capital and O&M costs, taxes and levies are aggregated according to the respective technologies. For instance, the CO₂ tax is included in the *Gas* category. The nuclear levy is included in the *Nuclear* category. The *Renewable* cost includes all the costs from geothermal, solar PV and wind, while wastes and biomass are reported separately. The *T&D network* is mainly the electricity surcharge applied to end-use sectors, along with the cost of the simplified transmission and distribution network in the model. As a caveat, the *T&D network* cost does not reflect the full cost of grid expansions. The *Import/Export* category includes all the costs associated with electricity trade and differs from *Trade Balance* by including the cost of capital and O&M for interconnection infrastructure.

3.1.3. CO₂ emissions

CO₂ emissions refer to emissions from gas-fired power plants and CHPs. In the case of net imported electricity, a life cycle emission factor of 462 g/kWh is applied, based on the 'current' average life cycle emission factor of EU electricity generation mix [6].

3.1.4. Generation schedule

The model reports the electricity generation schedule for three types of day (weekdays, Saturdays and Sundays) in four seasons. In the plots presenting the electricity generation schedule, the daily electricity demand is shown by a blue line that excludes T&D losses. Supply is always above the demand and the difference reflects the T&D losses, electricity used in pumps and exports. Exports and electricity used for pumped storage are also shown separately in the export figure. Note, the model may choose to import and export simultaneously (e.g., from one country to another). The red line in the plots presenting the generation schedule shows marginal cost of electricity (RHS axis).

⁷ The heat credit is equivalent to cost of natural gas replaced by the heat output of CHPs, assuming an equivalent amount of heat is produced from a boiler with an efficiency of 90%. A full heat credit is applied for fall and winter seasons, whereas in summer and spring seasons only 33% of the gas savings are accounted (i.e. for every three units of heat, only one unit of heat is credited, because heat demand is assumed to be lower in summer/spring). The heat credit is applied to heat from all type of CHP, i.e. including heat produced from biogas CHPs

3.2. Electricity generation mix

Figure 3 shows the electricity generation mix and total installed capacity in the year 2050 for the scenarios outlined in Table 1. The blue dots represent end-use electricity demand, excluding T&D losses.

- Up to 30% of the supply is met with gas-based electricity generation depending on the demand pathway and supply variant.
- Without nuclear or gas generation, almost all domestic renewable potential must be tapped. By 2050, renewables could contribute as much as one third of the supply. Import is inevitable except in the *NEP* demand pathway and accounts for 8-20% of the demand in *WWB* and *POM* scenarios.
- In all supply variants, expansion of interconnectors is inevitable.
- The role of electricity trade is very significant in balancing seasonal variations and generating revenues. Though net annual trade is assumed to be balanced in many of the scenarios, the system still relies on imported electricity in winter and spring seasons. The share of gas-based supply needs to be increased if electricity imports are fully restricted. For example, for the *POM* demand, about 12 gas power plants (in *P-Gas-S*) are needed compared to eight plants (in *P-Gas*) with seasonal import option (see Figure 4).
- Solar PV become attractive in all scenarios due to assumed cost reductions. The output of solar PV is utilized domestically in high demand scenarios, or exported in summer.
- Restricting imports in winter fully affects the attractiveness of solar PV and supports the deployment of additional gas power plants.
- The high uptake of pumped hydro in the nuclear supply variant is driven by system balancing needs on weekends, since the nuclear power plants are less flexible.

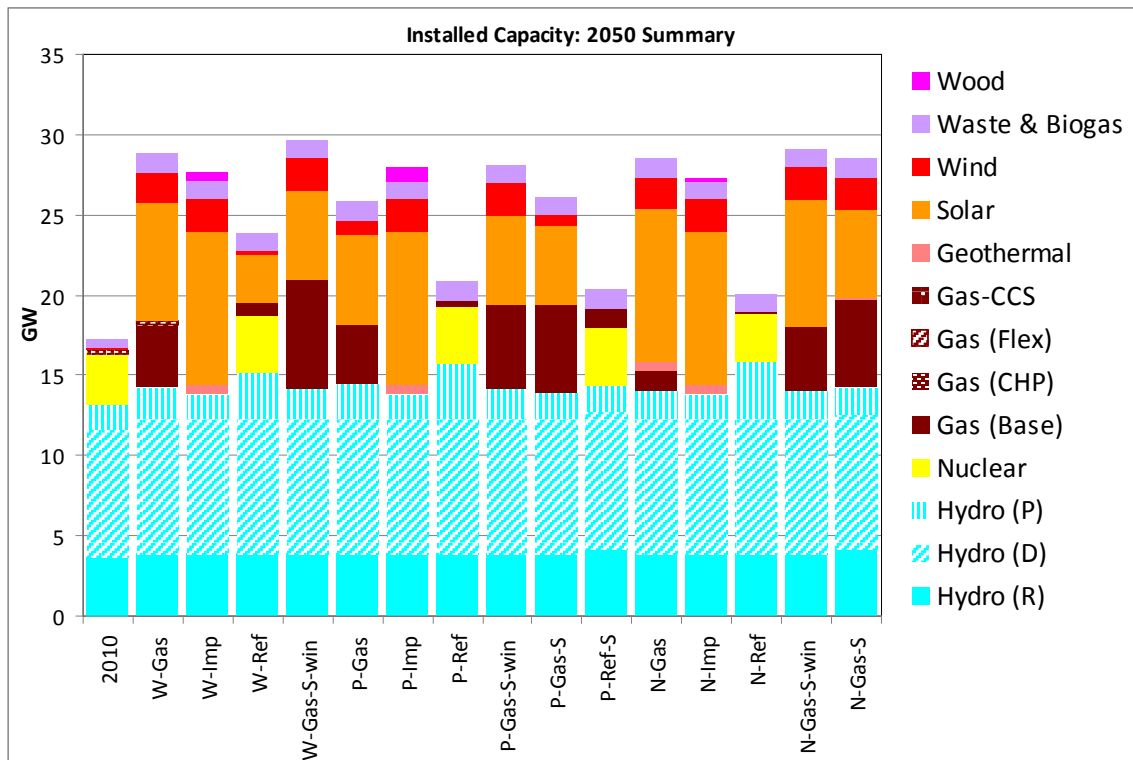
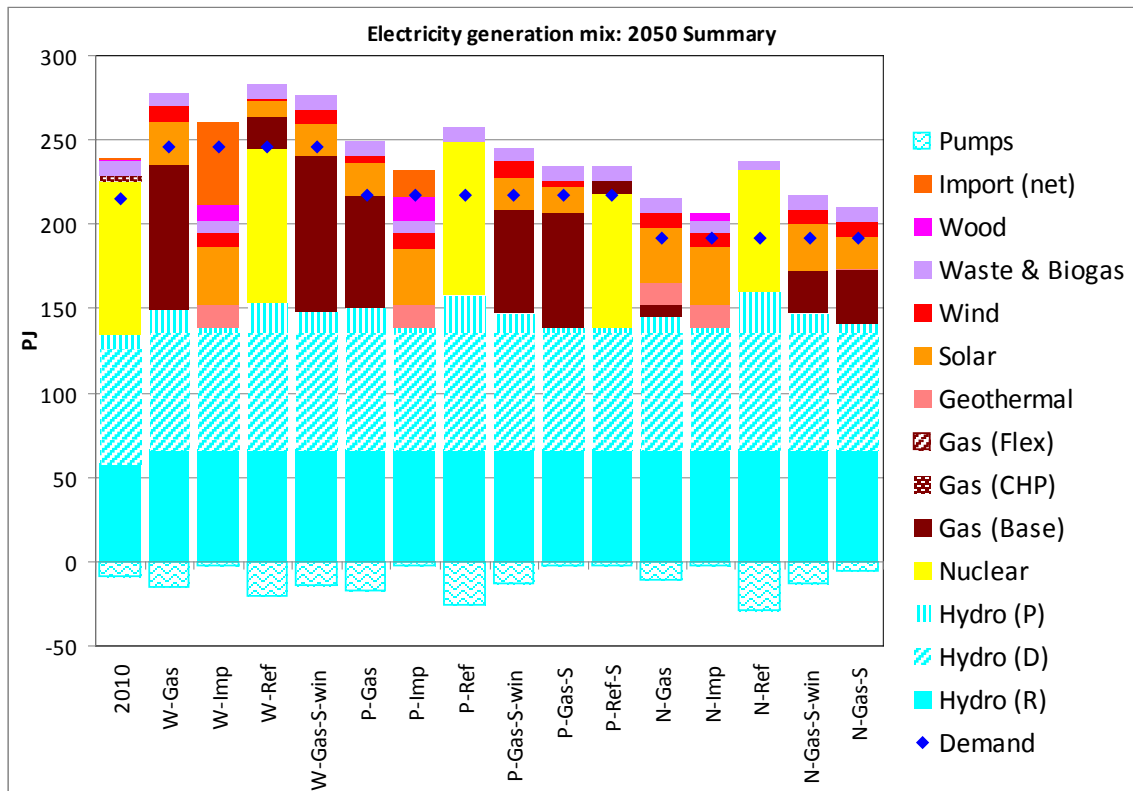


Figure 3: Electricity generation mix and installed capacity in 2050

3.3. Capacity expansion

Figure 4 shows cumulative capacity addition over the next 40 years (between 2013 and 2055). The Swiss electricity system could need:

- Up to 10 new gas combined cycle plants each of 550 MW depending on the demand pathway
- Up to 10 GW of solar PV and 2.5 GW wind.
- Almost all additions of hydro capacity in Figure 4 represent refurbishment of existing hydro plants. Thus, the net addition is relatively small.

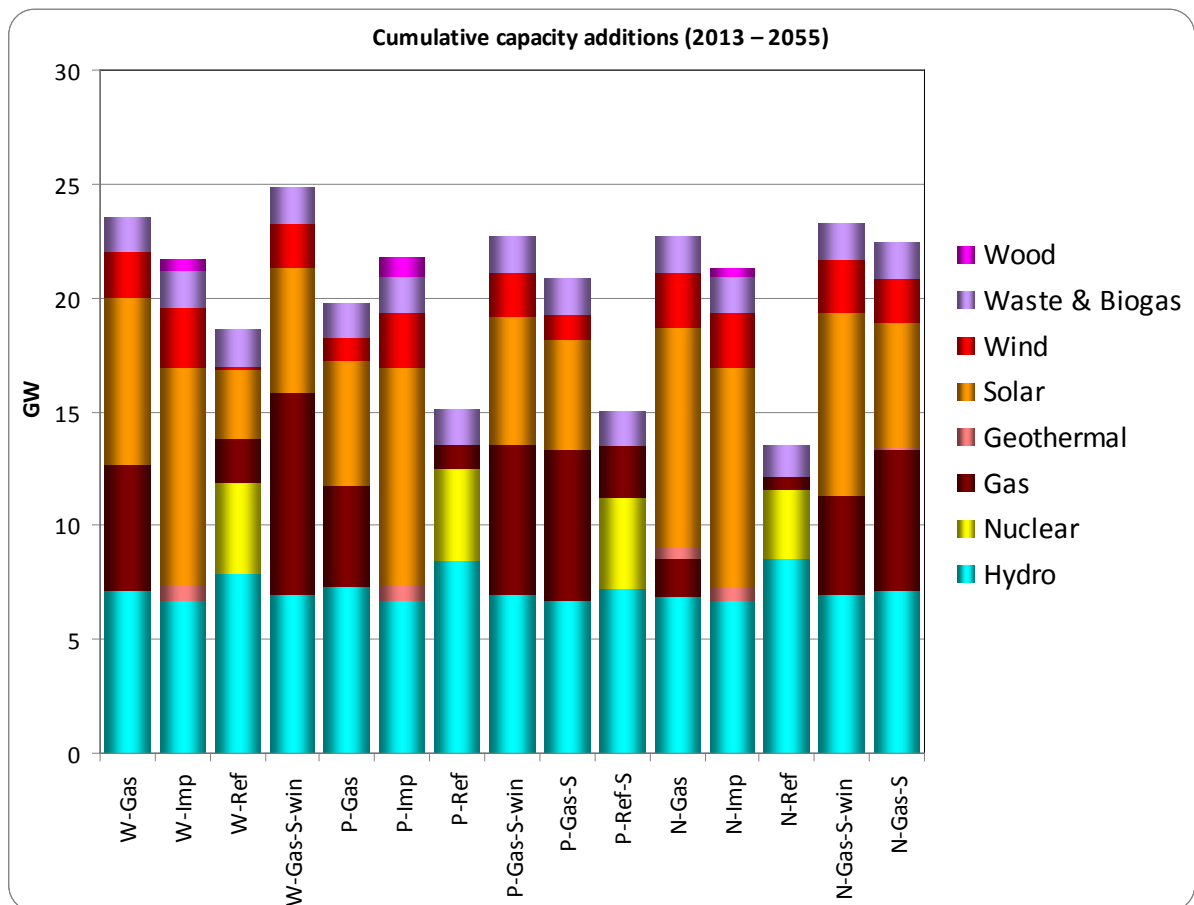
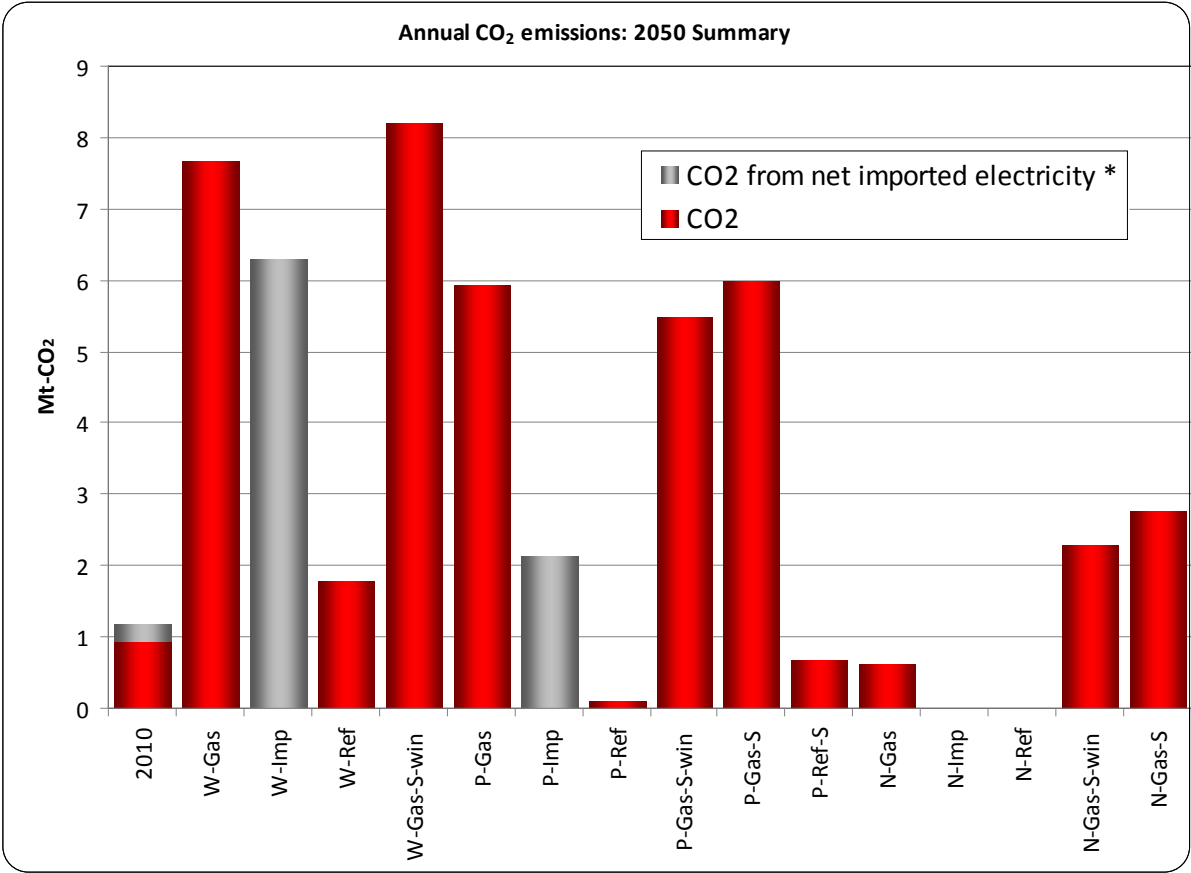


Figure 4: Cumulative capacity additions during 2013 – 2055

3.4. Emissions and costs

Figure 5 shows annual CO₂ emissions in 2050. It is important to note that CO₂ emissions for imported electricity (gray bars in Figure 5) are not considered in the model, but have been calculated based on the current average life cycle emission

intensity (460 g-CO₂/kWh_e) of European Union electricity generation [6]. Any variation in diurnal or seasonal emissions associated with trade is ignored in this estimate.



* For net imported electricity, a life cycle emission factor of 462 g/kWh [6] is applied based on the current EU electricity generation mix

Figure 5: Annual CO₂ emissions in 2050

Figure 6 shows electricity system cost in 2050 (see explanatory notes in §3.1 for description of cost categories). The cost does not include full costs associated with T&D network expansion/upgrade.

- Cost of supplying to the low demand is relatively cheap. Thus all N- supply variants have the lowest system cost. However, the current analysis does not include cost of realizing this lower demand.
- The nuclear supply variants appear to be the cheapest. But non-cost drivers (e.g. risk) are not considered in our analysis.

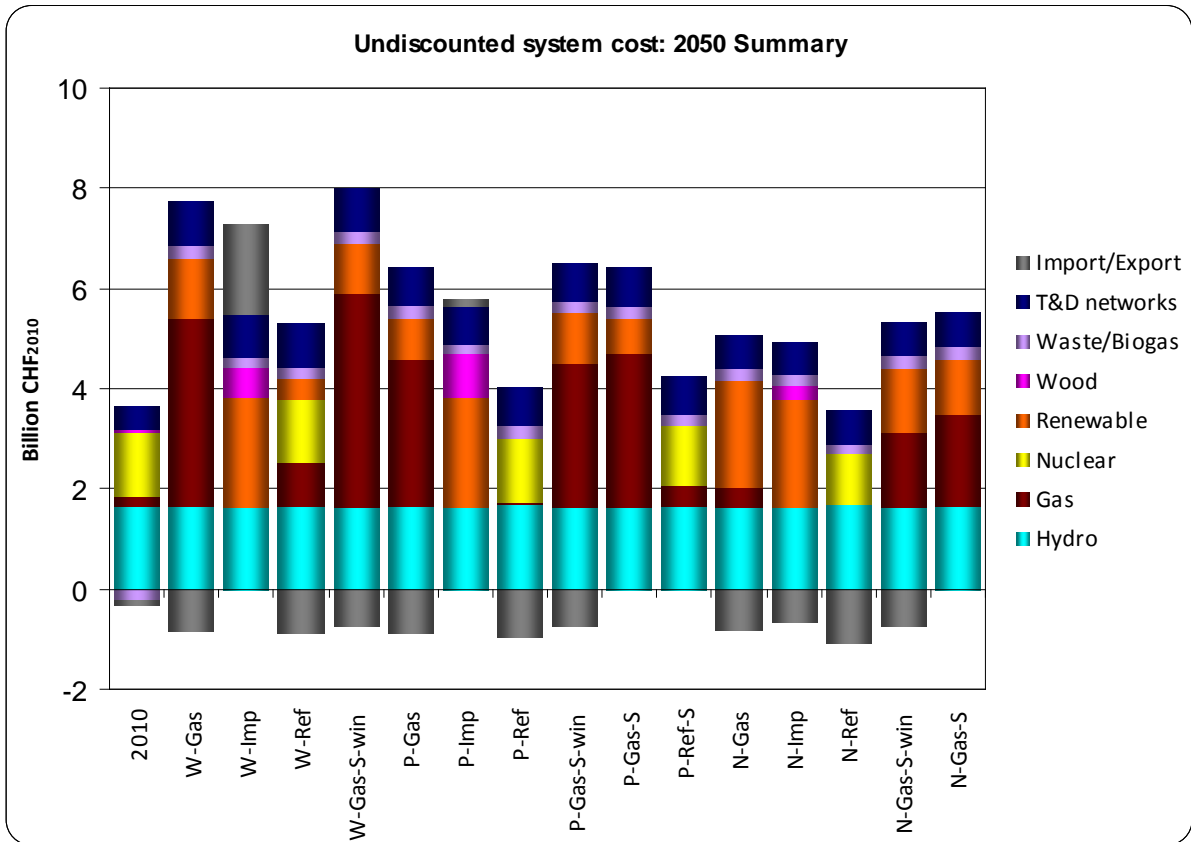
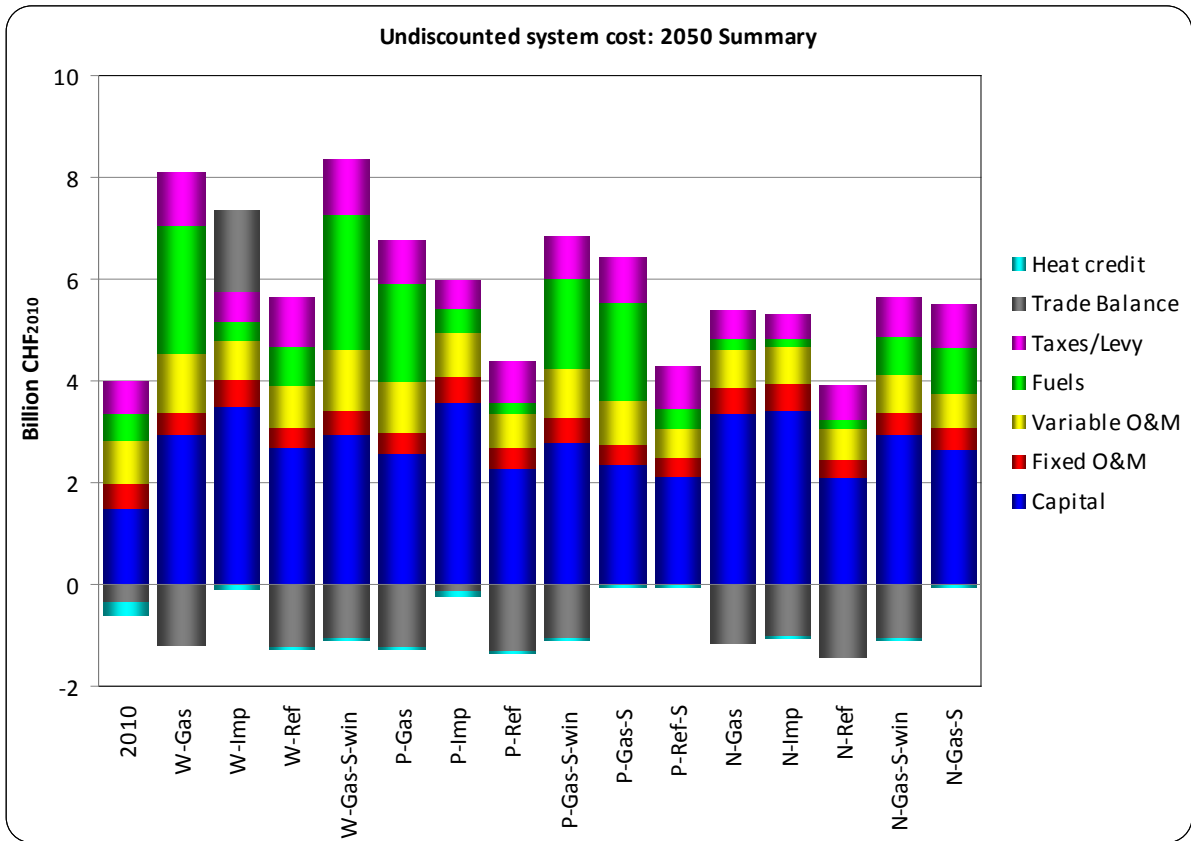


Figure 6: Undiscounted electricity system cost in 2050

Based on the net electricity system costs in Figure 6, an average cost of electricity is calculated and shown in Figure 7. If the revenue from electricity trade excluded, the average cost of electricity is higher (shown with gray bars).

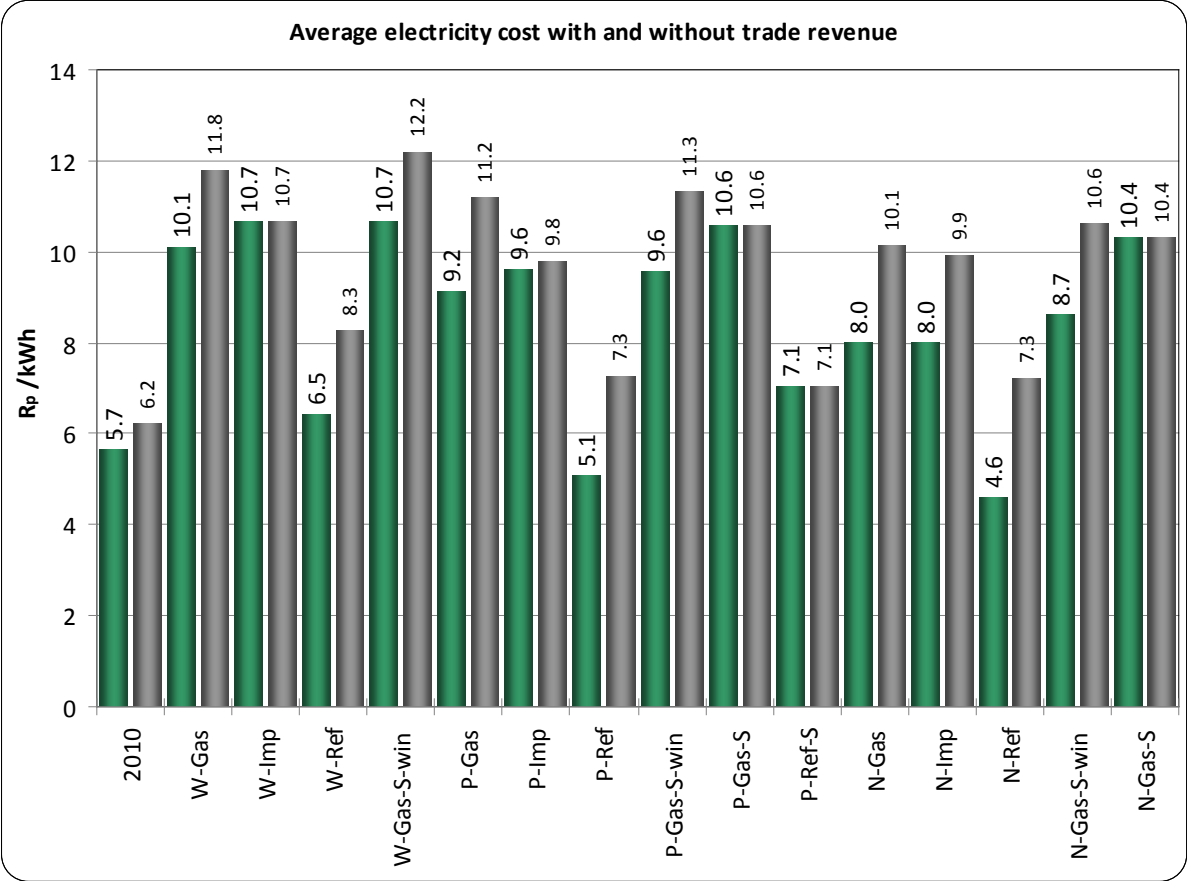


Figure 7: Average electricity cost in 2050

- The average cost of electricity is lower in the low demand scenarios. However, costs of demand reduction measures are not considered.
- Supply security variants have relatively higher costs reflecting the need for additional investments in generation capacity and the loss of trade revenues.
- The cost variations between renewable/import (-Imp) and gas (-Gas) supply variants are not significant. However, the cost of the -Imp supply variant is highly dependent on assumptions on imported electricity price and availability.

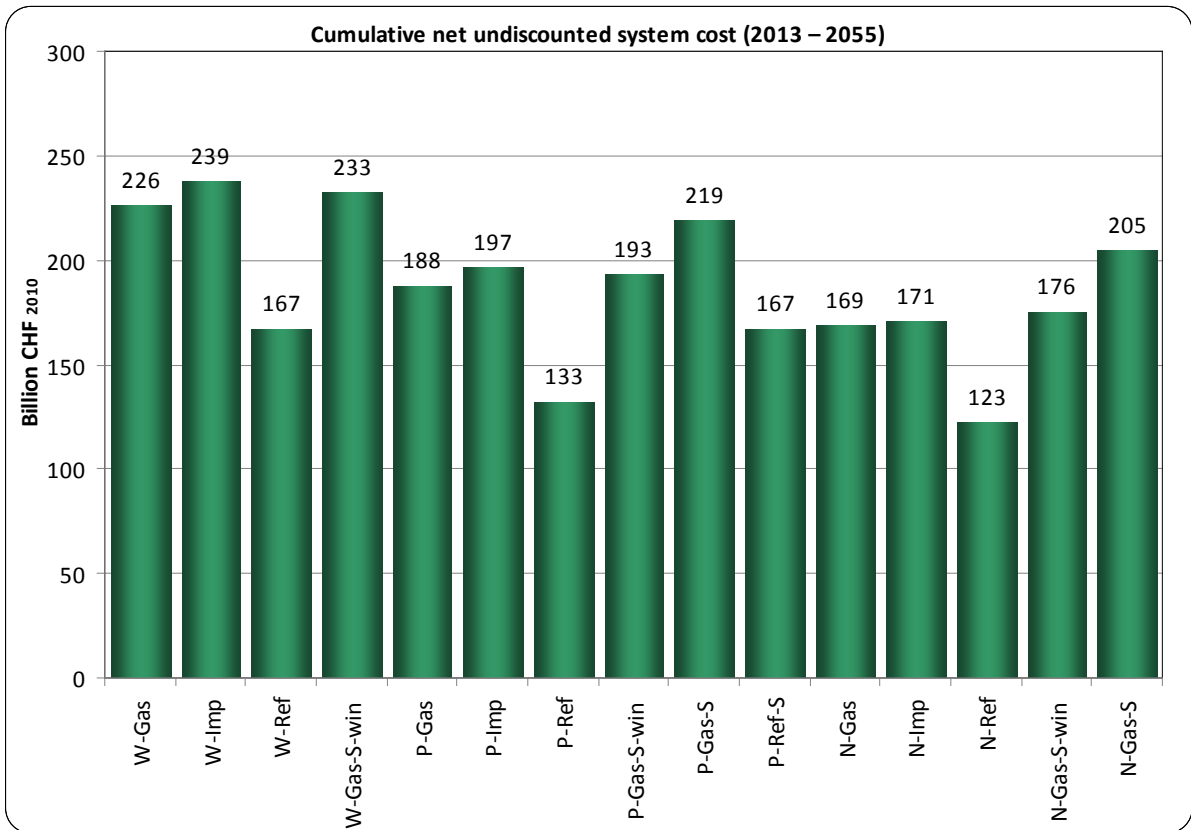
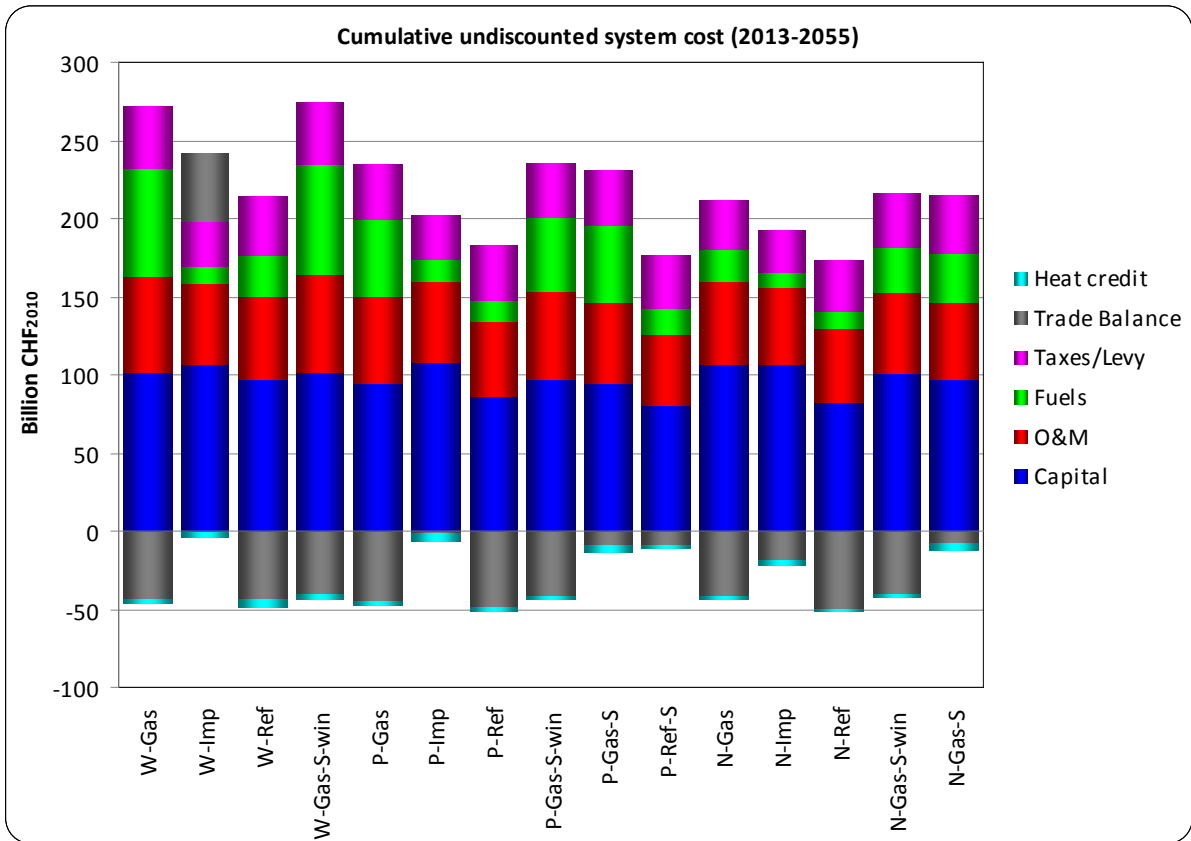


Figure 8: Cumulative (2013 -2055) cost of electricity system costs

Figure 8 shows cumulative undiscounted system cost between 2013 and 2055. In general, supplying a lower electricity demand is cheaper. However, the transition to a low electricity demand pathway would incur additional costs in the deployment of energy efficiency measures and new/emerging technologies at the end-use sectors. STEM-E optimises only the electricity supply side for the given set of electricity demands, and does not model demand reductions through efficiency measures or behaviour change. Accordingly, STEM-E is unable to provide insights regarding the cost or feasibility of realizing a certain level of demand reductions.

3.5. Electricity generation schedule

Unlike the many analysis reviewed (see Figure 2), the novel feature of STEM-E is that it offers additional insights into the balancing of electricity supply and demand at an hourly level. Figure 9 illustrates electricity schedule from Gas supply variants with POM demand (i.e. *P-Gas*) on weekdays.

- In all seasons, base-load generation is supplemented with electricity imports at night when trade prices are assumed to be low.
- The gas plants are not scheduled in summer because of low demand and the higher output from hydro plants in this season.
- During the day, dam hydro and pumped storage plants are scheduled, with the excess generation exported when export prices are high.
- The marginal cost of electricity (red line, right-hand axis) on weekdays varies between 11-16 Rp/kWh in summer and 14-19 Rp/kWh in winter.

The dynamics of the electricity generation schedule is extensively discussed in [10][12]. The generation schedules of other demand and supply variants are given in the Appendix.

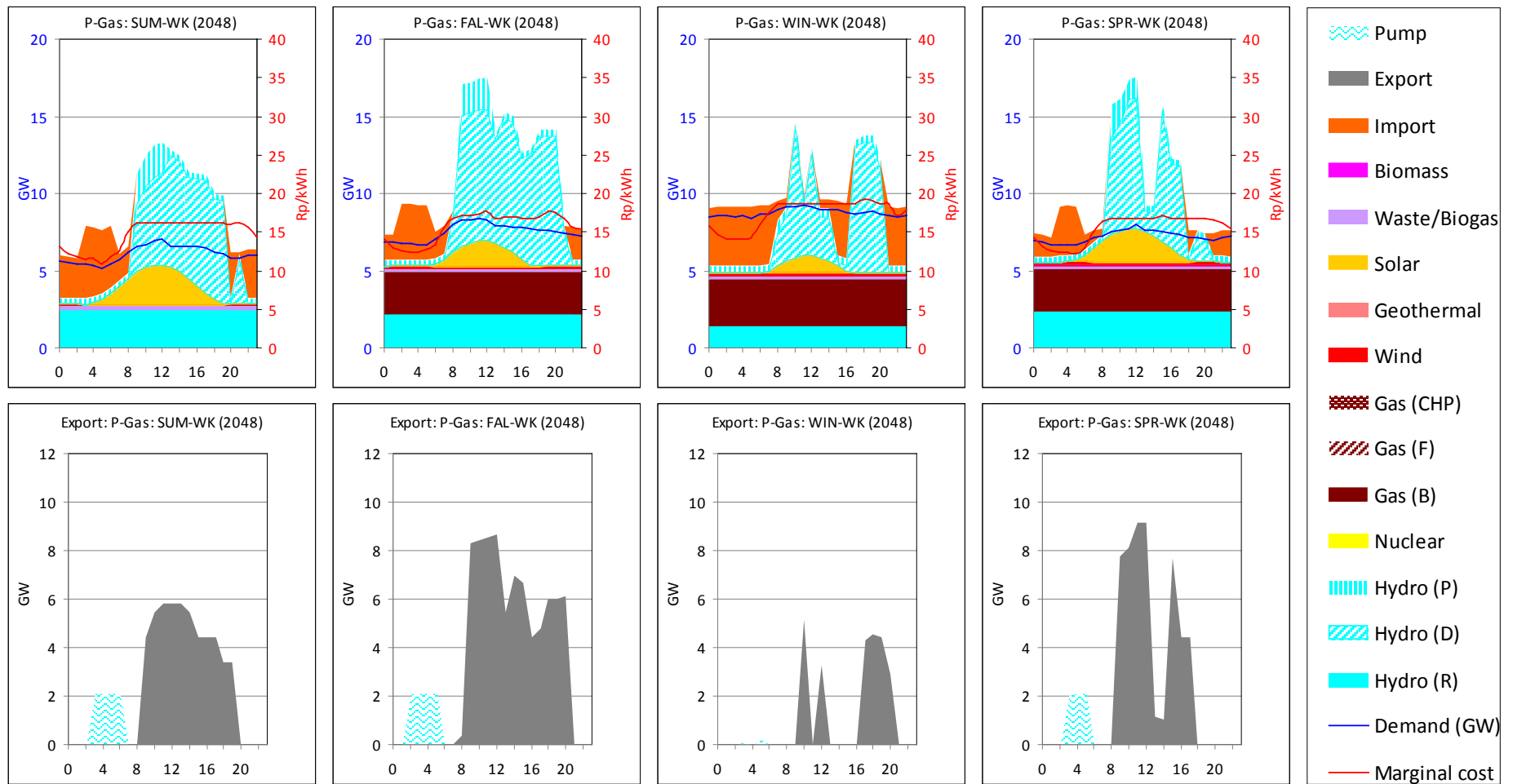


Figure 9: Electricity generation schedule on weekdays - P-Gas

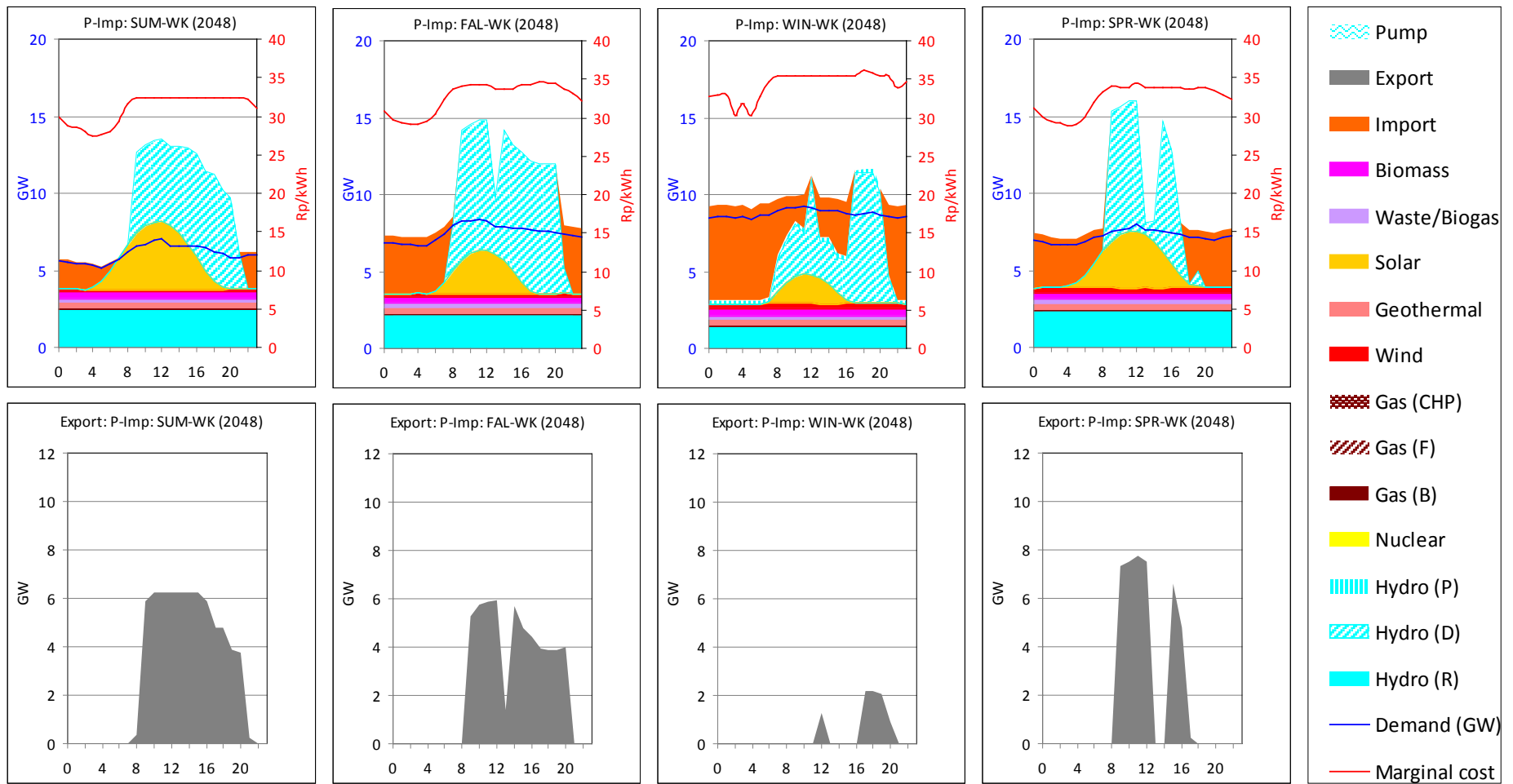


Figure 10: Electricity generation schedule on weekdays - *P-Imp*

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Appendixes

Appendixes

Appendix I: POM demand and gas based electricity supply (*P-Gas*) 1

Appendix II: POM demand and import/renewable electricity supply (*P-Imp*) 7

Appendix III: POM demand and nuclear electricity supply (*P-Ref*) 13

Appendix IV: NEP demand and gas based electricity supply (*N-Gas*) 19

Appendix V: NEP demand and import/renewable electricity supply (*N-Imp*) 25

Appendix VI: NEP demand and nuclear electricity supply (*N-Ref*) 31

Appendix VII: WWB demand and gas based electricity supply (*W-Gas*) 37

Appendix VIII: WWB demand and import/renewable electricity supply (*W-Imp*) 43

Appendix IX: WWB demand and nuclear electricity supply (*W-Ref*) 49

Appendix X: POM demand and gas based electricity supply with winter security (*P-Gas-S-win*) 55

Appendix XI: POM demand and gas based electricity supply with security (*P-Gas-S*) 61

Appendix XII: POM demand and nuclear electricity supply with security (*P-Ref-S*) 67

Appendix XIII: NEP demand and gas based electricity supply with winter security (*N-Gas-S-win*) 73

Appendix XIV: NEP demand and gas based electricity supply with supply security (*N-Gas-S*) 79

Appendix XV: WWB demand and gas electricity based supply with supply security (*W-Gas-S*) 85

List of figures in appendixes

Fig. A-I-1: Electricity generation mix – *P-Gas* 1

Fig. A-I-2: Installed capacity – *P-Gas* 2

Fig. A-I-3: Annual undiscounted system cost by cost category – *P-Gas* 3

Fig. A-I-4: Annual undiscounted system cost by technology category – *P-Gas* 4

Fig. A-I-5: Average cost of electricity – *P-Gas* 5

Fig. A-I-6: Annual CO₂ emissions – *P-Gas* 5

Fig. A-I-7: Electricity generation schedule on weekdays – *P-Gas* 6

Fig. A-II-8: Electricity generation mix – *P-Imp* 7

Fig. A-II-9: Installed capacity – *P-Imp* 8

Fig. A-II-10: Annual undiscounted system cost by cost category – *P-Imp* 9

Fig. A-II-11: Annual undiscounted system cost by technology category – *P-Imp* 10

Fig. A-II-12: Average cost of electricity – <i>P-Imp</i>	11
Fig. A-II-13: Annual CO ₂ emissions – <i>P-Imp</i>	11
Fig. A-II-14: Electricity generation schedule on weekdays – <i>P-Imp</i>	12
Fig. A-III-15: Electricity generation mix – <i>P-Ref</i>	13
Fig. A-III-16: Installed capacity – <i>P-Ref</i>	14
Fig. A-III-17: Annual undiscounted system cost by cost category – <i>P-Ref</i>	15
Fig. A-III-18: Annual undiscounted system cost by technology category – <i>P-Ref</i>	16
Fig. A-III-19: Average cost of electricity – <i>P-Ref</i>	17
Fig. A-III-20: Annual CO ₂ emissions – <i>P-Ref</i>	17
Fig. A-III-21: Electricity generation schedule on weekdays – <i>P-Ref</i>	18
Fig. A-IV-22: Electricity generation mix – <i>N-Gas</i>	19
Fig. A-IV-23: Installed capacity – <i>N-Gas</i>	20
Fig. A-IV-24: Annual undiscounted system cost by cost category – <i>N-Gas</i>	21
Fig. A-IV-25: Annual undiscounted system cost by technology category – <i>N-Gas</i>	22
Fig. A-IV-26: Average cost of electricity – <i>N-Gas</i>	23
Fig. A-IV-27: Annual CO ₂ emissions – <i>N-Gas</i>	23
Fig. A-IV-28: Electricity generation schedule on weekdays – <i>N-Gas</i>	24
Fig. A-V-29: Electricity generation mix – <i>N-Imp</i>	25
Fig. A-V-30: Installed capacity – <i>N-Imp</i>	26
Fig. A-V-31: Annual undiscounted system cost by cost category – <i>N-Imp</i>	27
Fig. A-V-32: Annual undiscounted system cost by technology category – <i>N-Imp</i>	28
Fig. A-V-33: Average cost of electricity – <i>N-Imp</i>	29
Fig. A-V-34: Annual CO ₂ emissions – <i>N-Imp</i>	29
Fig. A-V-35: Electricity generation schedule on weekdays – <i>N-Imp</i>	30
Fig. A-VI-36: Electricity generation mix – <i>N-Ref</i>	31
Fig. A-VI-37: Installed capacity – <i>N-Ref</i>	32
Fig. A-VI-38: Annual undiscounted system cost by cost category – <i>N-Ref</i>	33
Fig. A-VI-39: Annual undiscounted system cost by technology category – <i>N-Ref</i>	34
Fig. A-VI-40: Average cost of electricity – <i>N-Ref</i>	35

Fig. A-VI-41: Annual CO ₂ emissions – <i>N-Ref</i>	35
Fig. A-VI-42: Electricity generation schedule on weekdays – <i>N-Ref</i>	36
Fig. A-VII-43: Electricity generation mix – <i>W-Gas</i>	37
Fig. A-VII-44: Installed capacity – <i>W-Gas</i>	38
Fig. A-VII-45: Annual undiscounted system cost by cost category – <i>W-Gas</i>	39
Fig. A-VII-46: Annual undiscounted system cost by technology category – <i>W-Gas</i>	40
Fig. A-VII-47: Average cost of electricity – <i>W-Gas</i>	41
Fig. A-VII-48: Annual CO ₂ emissions – <i>W-Gas</i>	41
Fig. A-VII-49: Electricity generation schedule on weekdays – <i>W-Gas</i>	42
Fig. A-VIII-50: Electricity generation mix – <i>W-Imp</i>	43
Fig. A-VIII-51: Installed capacity – <i>W-Imp</i>	44
Fig. A-VIII-52: Annual undiscounted system cost by cost category – <i>W-Imp</i>	45
Fig. A-VIII-53: Annual undiscounted system cost by technology category – <i>W-Imp</i>	46
Fig. A-VIII-54: Average cost of electricity – <i>W-Imp</i>	47
Fig. A-VIII-55: Annual CO ₂ emissions – <i>W-Imp</i>	47
Fig. A-VIII-56: Electricity generation schedule on weekdays – <i>W-Imp</i>	48
Fig. A-IX-57: Electricity generation mix – <i>W-Ref</i>	49
Fig. A-IX-58: Installed capacity – <i>W-Ref</i>	50
Fig. A-IX-59: Annual undiscounted system cost by cost category – <i>W-Ref</i>	51
Fig. A-IX-60: Annual undiscounted system cost by technology category – <i>W-Ref</i>	52
Fig. A-IX-61: Average cost of electricity – <i>W-Ref</i>	53
Fig. A-IX-62: Annual CO ₂ emissions – <i>W-Ref</i>	53
Fig. A-IX-63: Electricity generation schedule on weekdays – <i>W-Ref</i>	54
Fig. A-X-64: Electricity generation mix – <i>P-Gas-S-win</i>	55
Fig. A-X-65: Installed capacity – <i>P-Gas-S-win</i>	56
Fig. A-X-66: Annual undiscounted system cost by cost category – <i>P-Gas-S-win</i>	57
Fig. A-X-67: Annual undiscounted system cost by technology category – <i>P-Gas-S-win</i>	58
Fig. A-X-68: Average cost of electricity – <i>P-Gas-S-win</i>	59
Fig. A-X-69: Annual CO ₂ emissions – <i>P-Gas-S-win</i>	59

Fig. A-X-70: Electricity generation schedule on weekdays – <i>P-Gas-S-win</i>	60
Fig. A-XI-71: Electricity generation mix – <i>P-Gas-S</i>	61
Fig. A-XI-72: Installed capacity – <i>P-Gas-S</i>	62
Fig. A-XI-73: Annual undiscounted system cost by cost category – <i>P-Gas-S</i>	63
Fig. A-XI-74: Annual undiscounted system cost by technology category – <i>P-Gas-S</i>	64
Fig. A-XI-75: Average cost of electricity – <i>P-Gas-S</i>	65
Fig. A-XI-76: Annual CO ₂ emissions – <i>P-Gas-S</i>	65
Fig. A-XI-77: Electricity generation schedule on weekdays – <i>P-Gas-S</i>	66
Fig. A-XII-78: Electricity generation mix – <i>P-Ref-S</i>	67
Fig. A-XII-79: Installed capacity – <i>P-Ref-S</i>	68
Fig. A-XII-80: Annual undiscounted system cost by cost category – <i>P-Ref-S</i>	69
Fig. A-XII-81: Annual undiscounted system cost by technology category – <i>P-Ref-S</i>	70
Fig. A-XII-82: Average cost of electricity – <i>P-Ref-S</i>	71
Fig. A-XII-83: Annual CO ₂ emissions – <i>P-Ref-S</i>	71
Fig. A-XII-84: Electricity generation schedule on weekdays – <i>P-Ref-S</i>	72
Fig. A-XIII-85: Electricity generation mix – <i>N-Gas-S-win</i>	73
Fig. A-XIII-86: Installed capacity – <i>N-Gas-S-win</i>	74
Fig. A-XIII-87: Annual undiscounted system cost by cost category – <i>N-Gas-S-win</i>	75
Fig. A-XIII-88: Annual undiscounted system cost by technology category – <i>N-Gas-S-win</i>	76
Fig. A-XIII-89: Average cost of electricity – <i>N-Gas-S-win</i>	77
Fig. A-XIII-90: Annual CO ₂ emissions – <i>N-Gas-S-win</i>	77
Fig. A-XIII-91: Electricity generation schedule on weekdays – <i>N-Gas-S-win</i>	78
Fig. A-XIV-92: Electricity generation mix – <i>N-Gas-S</i>	79
Fig. A-XIV-93: Installed capacity – <i>N-Gas-S</i>	80
Fig. A-XIV-94: Annual undiscounted system cost by cost category – <i>N-Gas-S</i>	81
Fig. A-XIV-95: Annual undiscounted system cost by technology category – <i>N-Gas-S</i>	82
Fig. A-XIV-96: Average cost of electricity – <i>N-Gas-S</i>	83
Fig. A-XIV-97: Annual CO ₂ emissions – <i>N-Gas-S</i>	83
Fig. A-XIV-98: Electricity generation schedule on weekdays – <i>N-Gas-S</i>	84

Fig. A-XV-99: Electricity generation mix – *W-Gas-S*..... 85

Fig. A-XV-100: Installed capacity – *W-Gas-S* 86

Fig. A-XV-101: Annual undiscounted system cost by cost category – *W-Gas-S*..... 87

Fig. A-XV-102: Annual undiscounted system cost by technology category – *W-Gas-S*..... 88

Fig. A-XV-103: Average cost of electricity – *W-Gas-S*..... 89

Fig. A-XV-104: Annual CO₂ emissions – *W-Gas-S*..... 89

Fig. A-XV-105: Electricity generation schedule on weekdays – *W-Gas-S*..... 90

List of tables in appendixes

Tab. A-I-1: Electricity generation mix: *P-Gas* 1

Tab. A-I-2: Installed capacity – *P-Gas*..... 2

Tab. A-I-3: Annual undiscounted system cost by category – *P-Gas*..... 3

Tab. A-I-4: Annual undiscounted system cost by technology – *P-Gas*..... 4

Tab. A-II-5: Electricity generation mix: *P-Imp*..... 7

Tab. A-II-6: Installed capacity – *P-Imp* 8

Tab. A-II-7: Annual undiscounted system cost by category – *P-Imp* 9

Tab. A-II-8: Annual undiscounted system cost by technology – *P-Imp*..... 10

Tab. A-III-9: Electricity generation mix: *P-Ref* 13

Tab. A-III-10: Installed capacity – *P-Ref*..... 14

Tab. A-III-11: Annual undiscounted system cost by category – *P-Ref*..... 15

Tab. A-III-12: Annual undiscounted system cost by technology – *P-Ref*..... 16

Tab. A-IV-13: Electricity generation mix: *N-Gas*..... 19

Tab. A-IV-14: Installed capacity (*GW*): *N-Gas* 20

Tab. A-IV-15: Annual undiscounted system cost by category – *N-Gas* 21

Tab. A-IV-16: Annual undiscounted system cost by technology – *N-Gas* 22

Tab. A-V-17: Electricity generation mix: *N-Imp* 25

Tab. A-V-18: Installed capacity – *N-Imp*..... 26

Tab. A-V-19: Annual undiscounted system cost by category – *N-Imp*..... 27

Tab. A-V-20: Annual undiscounted system cost by technology – *N-Imp*..... 28

Tab. A-VI-21: Electricity generation mix: <i>N-Ref</i>	31
Tab. A-VI-22: Installed capacity – <i>N-Ref</i>	32
Tab. A-VI-23: Annual undiscounted system cost by category – <i>N-Ref</i>	33
Tab. A-VI-24: Annual undiscounted system cost by technology – <i>N-Ref</i>	34
Tab. A-VII-25: Electricity generation mix: <i>W-Gas</i>	37
Tab. A-VII-26: Installed capacity – <i>W-Gas</i>	38
Tab. A-VII-27: Annual undiscounted system cost by category – <i>W-Gas</i>	39
Tab. A-VII-28: Annual undiscounted system cost by technology – <i>W-Gas</i>	40
Tab. A-VIII-29: Electricity generation mix: <i>W-Imp</i>	43
Tab. A-VIII-30: Installed capacity – <i>W-Imp</i>	44
Tab. A-VIII-31: Annual undiscounted system cost by category – <i>W-Imp</i>	45
Tab. A-VIII-32: Annual undiscounted system cost by technology – <i>W-Imp</i>	46
Tab. A-IX-33: Electricity generation mix: <i>W-Ref</i>	49
Tab. A-IX-34: Installed capacity – <i>W-Ref</i>	50
Tab. A-IX-35: Annual undiscounted system cost by category – <i>W-Ref</i>	51
Tab. A-IX-36: Annual undiscounted system cost by technology – <i>W-Ref</i>	52
Tab. A-X-37: Electricity generation mix: <i>P-Gas-S-win</i>	55
Tab. A-X-38: Installed capacity – <i>P-Gas-S-win</i>	56
Tab. A-X-39: Annual undiscounted system cost by category – <i>P-Gas-S-win</i>	57
Tab. A-X-40: Annual undiscounted system cost by technology – <i>P-Gas-S-win</i>	58
Tab. A-XI-41: Electricity generation mix: <i>P-Gas-S</i>	61
Tab. A-XI-42: Installed capacity – <i>P-Gas-S</i>	62
Tab. A-XI-43: Annual undiscounted system cost by category – <i>P-Gas-S</i>	63
Tab. A-XI-44: Annual undiscounted system cost by technology – <i>P-Gas-S</i>	64
Tab. A-XII-45: Electricity generation mix: <i>P-Ref-S</i>	67
Tab. A-XII-46: Installed capacity – <i>P-Ref-S</i>	68
Tab. A-XII-47: Annual undiscounted system cost by category – <i>P-Ref-S</i>	69
Tab. A-XII-48: Annual undiscounted system cost by technology – <i>P-Ref-S</i>	70
Tab. A-XIII-49: Electricity generation mix: <i>N-Gas-S-win</i>	73

Tab. A-XIII-50: Installed capacity – <i>N-Gas-S-win</i>	74
Tab. A-XIII-51: Annual undiscounted system cost by category – <i>N-Gas-S-win</i>	75
Tab. A-XIII-52: Annual undiscounted system cost by technology – <i>N-Gas-S-win</i>	76
Tab. A-XIV-53: Electricity generation mix: <i>N-Gas-S</i>	79
Tab. A-XIV-54: Installed capacity – <i>N-Gas-S</i>	80
Tab. A-XIV-55: Annual undiscounted system cost by category – <i>N-Gas-S</i>	81
Tab. A-XIV-56: Annual undiscounted system cost by technology – <i>N-Gas-S</i>	82
Tab. A-XV-57: Electricity generation mix: <i>W-Gas-S</i>	85
Tab. A-XV-58: Installed capacity – <i>W-Gas-S</i>	86
Tab. A-XV-59: Annual undiscounted system cost by category – <i>W-Gas-S</i>	87
Tab. A-XV-60: Annual undiscounted system cost by technology – <i>W-Gas-S</i>	88

Appendix I: POM demand and gas based electricity supply (P-Gas)

Tab. A-I-1: Electricity generation mix: P-Gas

Electricity generation mix (PJ): P-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			3	20	46	67	53
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	136	145	147	151	151	148
Renewable	9	8	8	8	27	31	46
Pumps	-9	-10	-14	-15	-18	-17	-14
Total	229	229	226	224	220	232	233

Renewable electricity generation (PJ): P-Gas

Geothermal							
Solar	0	0	0	0	19	19	35
Wind	0	0	0	0	0	4	3
Waste & Biogas	8	7	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	27	31	46
Net electricity import	2				0		

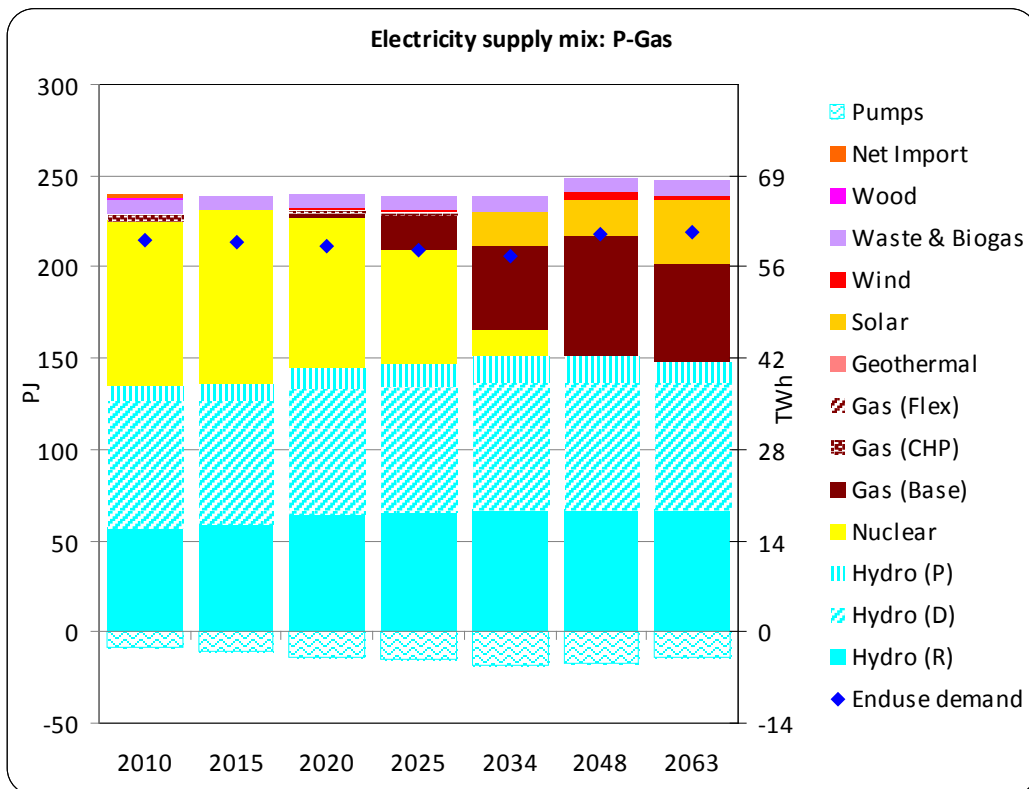


Fig. A-I-1: Electricity generation mix – P-Gas

Tab. A-I-2: Installed capacity – P-Gas

Installed Capacity (GW): P-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.4	1.1	3.6	3.7	2.9
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.5	14.0	13.8	14.1	14.5	14.5
Renewable	0.7	0.5	0.7	1.0	6.7	7.7	12.0
Total	17.3	17.5	18.1	18.1	24.9	25.8	29.3

Renewable Capacity (GW): P-Gas

Geothermal							
Solar	0.0	0.0	0.0	0.0	5.5	5.5	10.2
Wind	0.0	0.0	0.0	0.0	0.0	1.0	0.6
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.5	0.7	1.0	6.7	7.7	12.0

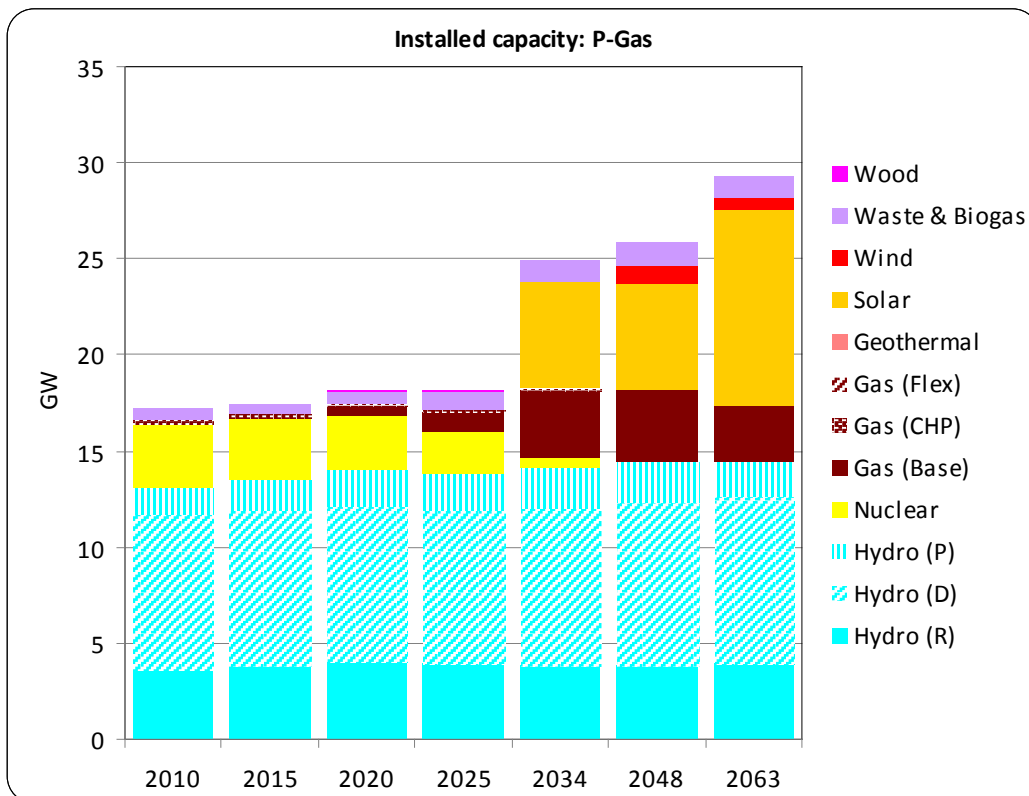


Fig. A-I-2: Installed capacity – P-Gas

Tab. A-I-3: Annual undiscounted system cost by category – P-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): P-Gas

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.3	0.4	0.7	1.1	1.9	1.5
Capital	1.5	1.5	1.6	1.7	2.5	2.6	3.2
Variable O&M	0.8	0.7	0.7	0.8	0.8	1.0	0.9
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.8	0.9	0.8
Trade Balance	-0.3	-0.5	-0.7	-0.9	-1.2	-1.2	-1.2
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.1	3.4	4.4	5.5	5.6

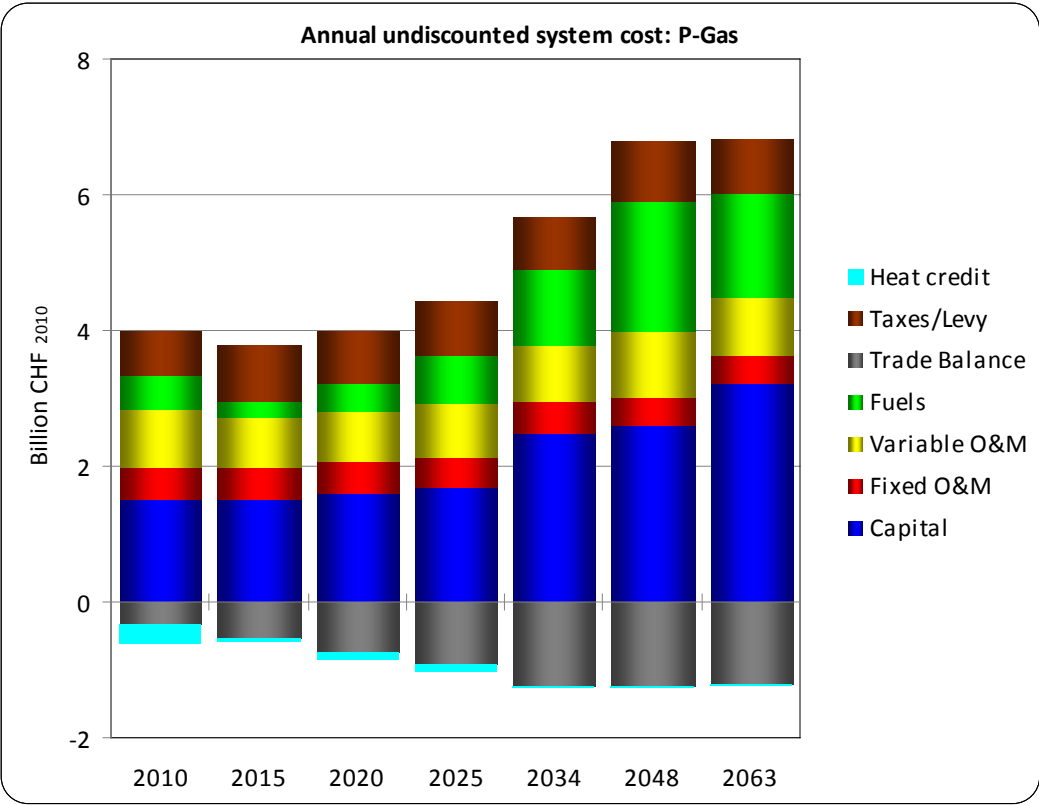


Fig. A-I-3: Annual undiscounted system cost by cost category – P-Gas

Tab. A-I-4: Annual undiscounted system cost by technology – P-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): P-Gas

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.8
Gas	0.2	0.0	0.2	0.8	1.9	2.9	2.4
Nuclear	1.3	1.3	1.1	0.9	0.1	0.8	1.2
Renewable				0.0	0.7	0.8	1.2
Wood	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.4	-0.6	-0.8	-1.0	-0.9	-0.8
Total	3.4	3.2	3.1	3.4	4.4	5.5	5.6

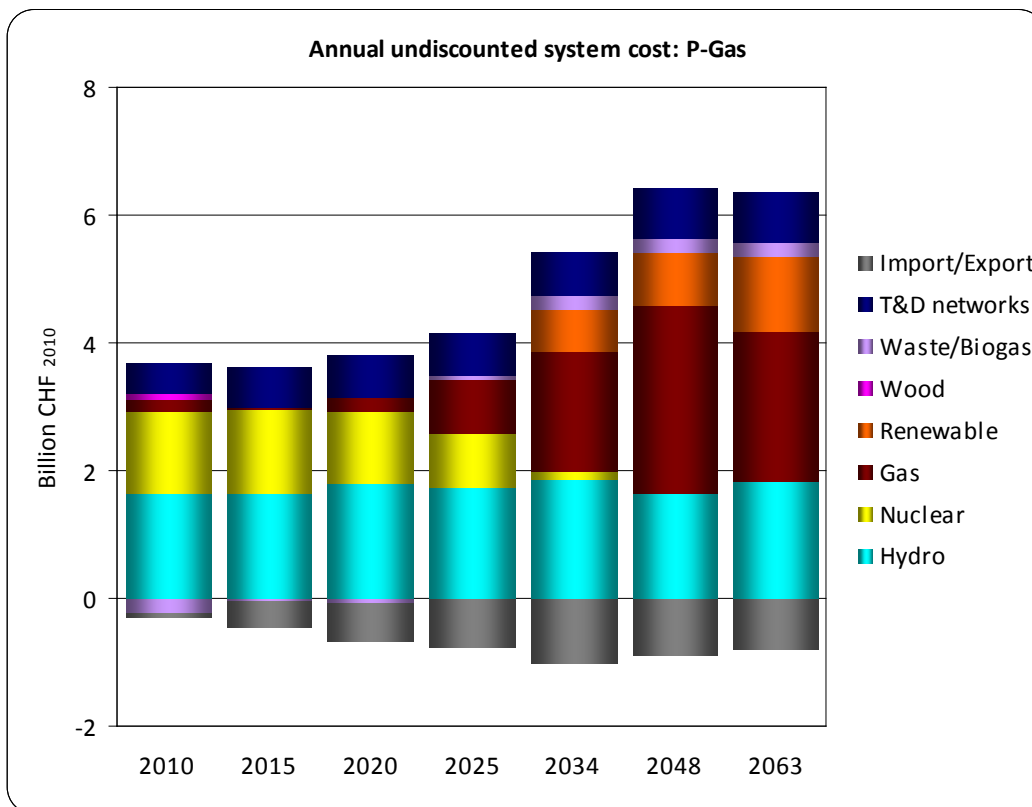


Fig. A-I-4: Annual undiscounted system cost by technology category – P-Gas

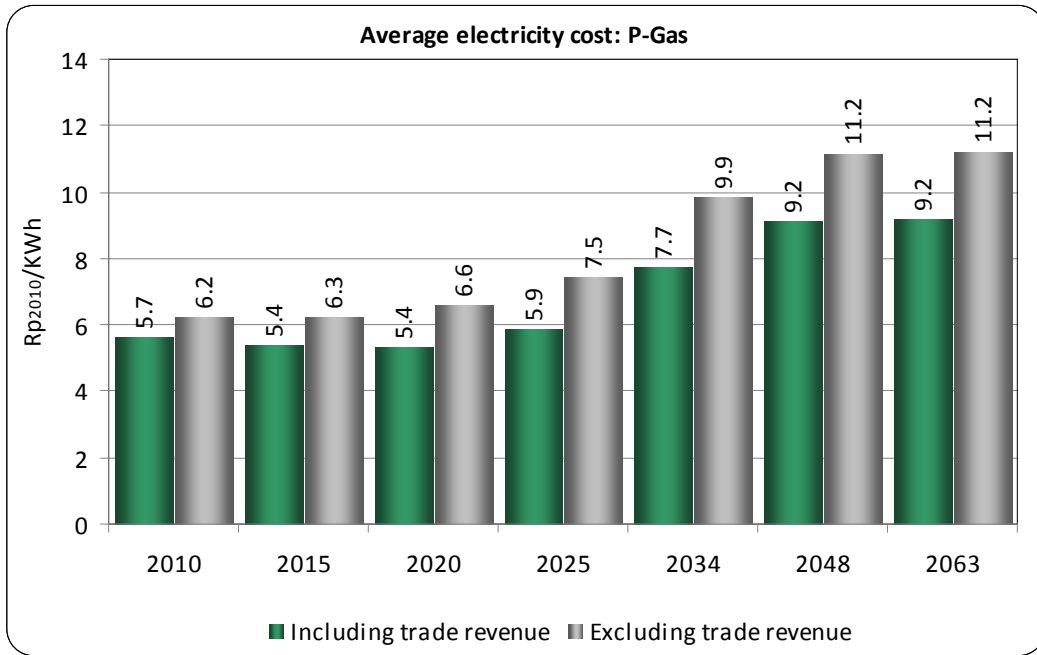


Fig. A-I-5: Average cost of electricity – P-Gas

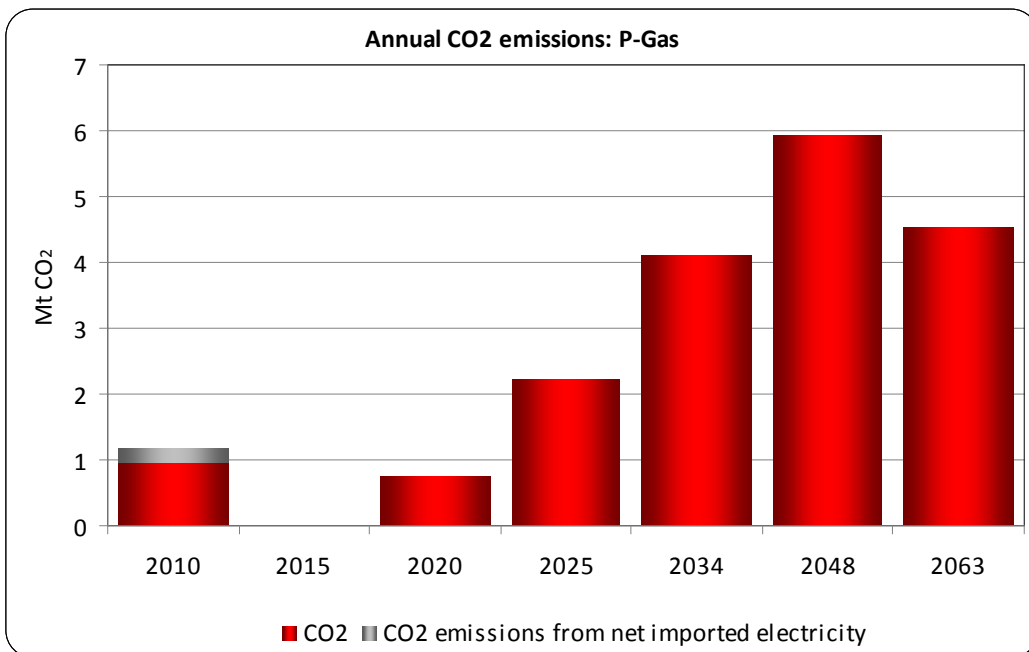


Fig. A-I-6: Annual CO₂ emissions – P-Gas

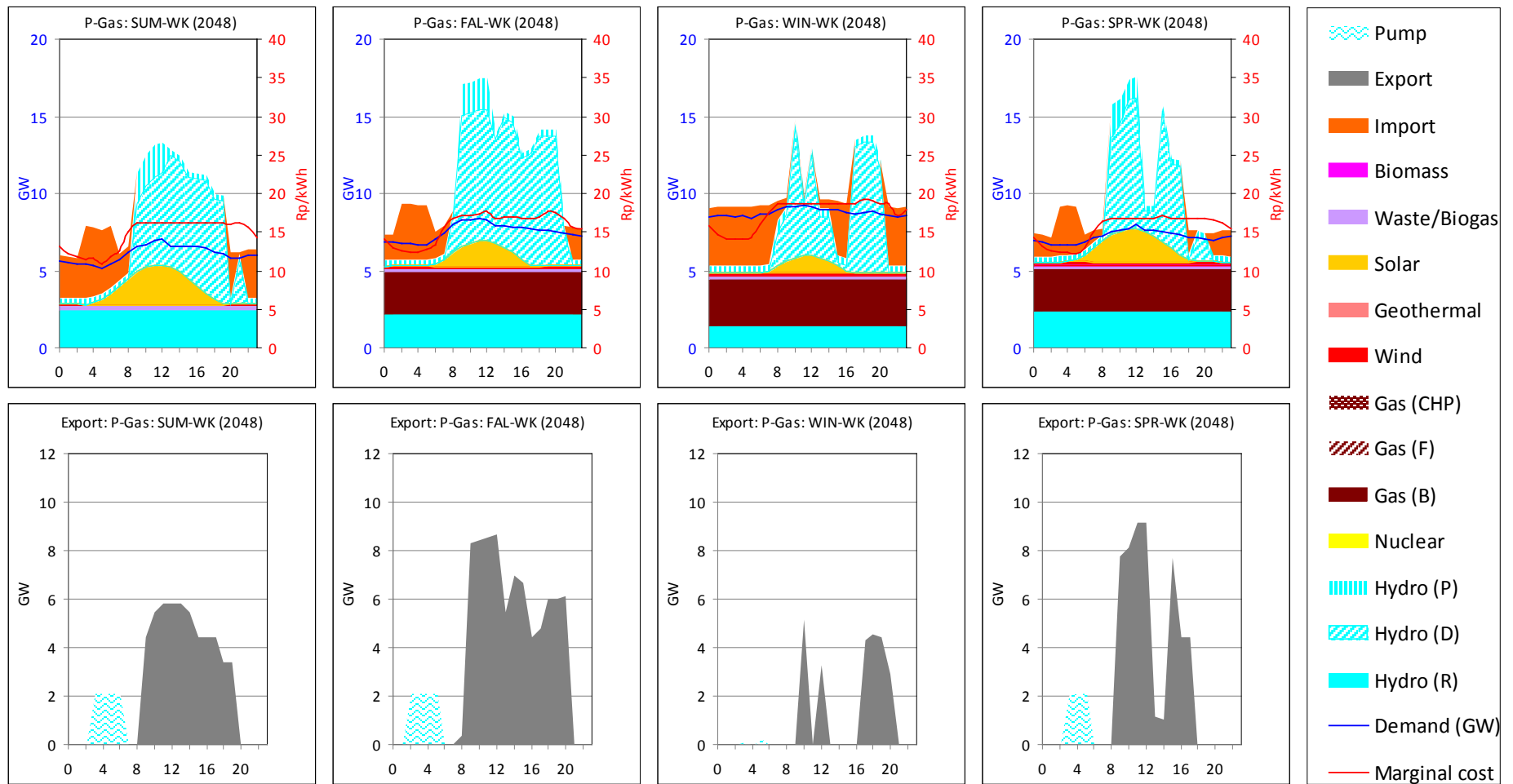


Fig. A-I-7: Electricity generation schedule on weekdays – P-Gas

Appendix II: POM demand and import/renewable electricity supply (*P-Imp*)

Tab. A-II-5: Electricity generation mix: *P-Imp*

Electricity generation mix (*PJ*): *P-Imp*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	3	3	2	1	0		
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	131	139	140	139	139	140
Renewable	9	8	8	9	38	77	79
Pumps	-9	-4	-6	-6	-2	-2	-3
Total	229	233	225	207	189	214	216

Renewable electricity generation (*PJ*): *P-Imp*

Geothermal				1	4	14	16
Solar	0	0	0	0	19	33	35
Wind	0	0	0	0	4	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1				3	13	11
Total renewable	9	8	8	9	38	77	79
Net electricity import	2		1	16	30	17	16

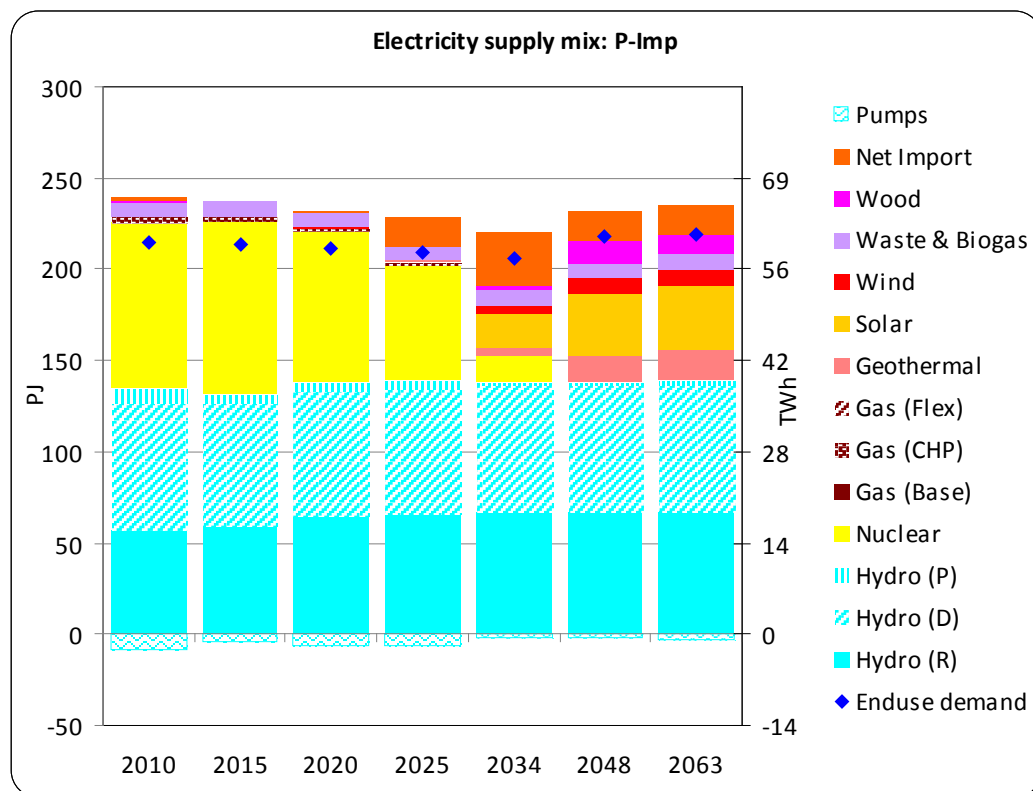


Fig. A-II-8: Electricity generation mix – *P-Imp*

Tab. A-II-6: Installed capacity – P-Imp

Installed Capacity (GW): P-Imp

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.3	13.6	13.4	13.5	13.8	13.8
Renewable	0.7	0.6	0.7	1.0	8.0	14.1	14.8
Total	17.3	17.3	17.3	16.7	21.9	27.9	28.6

Renewable Capacity (GW): P-Imp

Geothermal				0	0	1	1
Solar	0.0	0.0	0.0	0.0	5.5	9.6	10.2
Wind	0.0	0.0	0.0	0.0	0.9	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.2	0.8	0.7
Total renewable	0.7	0.6	0.7	1.0	8.0	14.1	14.8

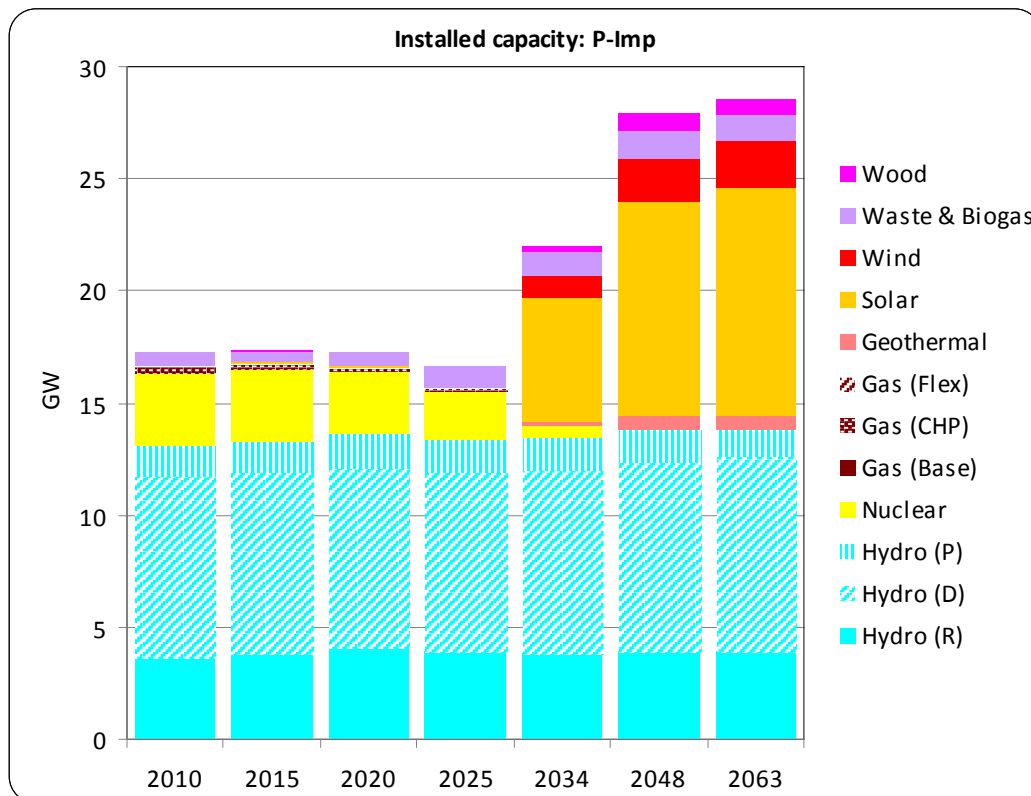


Fig. A-II-9: Installed capacity – P-Imp

Tab. A-II-7: Annual undiscounted system cost by category – P-Imp

Undiscounted system cost (Billion CHF₂₀₁₀): P-Imp

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.3	0.2	0.2	0.5	0.4
Capital	1.5	1.5	1.6	1.6	2.5	3.6	3.9
Variable O&M	0.8	0.7	0.7	0.7	0.6	0.8	0.8
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.7	0.6	0.5	0.5
Trade Balance	-0.3	-0.6	-0.6	-0.1	0.6	-0.1	-0.2
Heat credit	-0.3	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1
Total cost	3.4	3.2	3.1	3.4	4.8	5.8	6.0

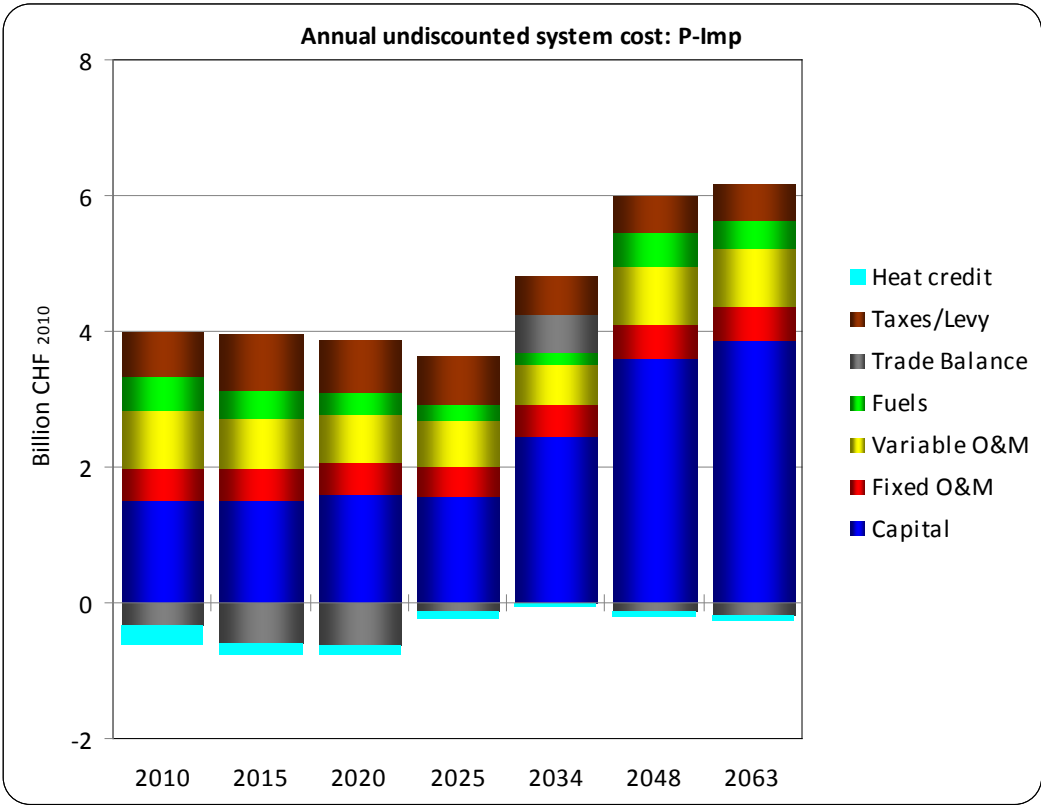


Fig. A-II-10: Annual undiscounted system cost by cost category – P-Imp

Tab. A-II-8: Annual undiscounted system cost by technology – P-Imp

Undiscounted system cost (Billion CHF₂₀₁₀): P-Imp

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.6	1.8
Gas	0.2	0.2	0.1	0.1	0.0		
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	1.0	2.2	2.3
Wood	0.1	0.0	0.0	0.0	0.2	0.9	0.7
Waste/Biogas	-0.2	-0.1	-0.1	0.1	0.2	0.2	0.1
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.5	-0.5	0.0	0.8	0.2	0.2
Total	3.4	3.2	3.1	3.4	4.8	5.8	6.0

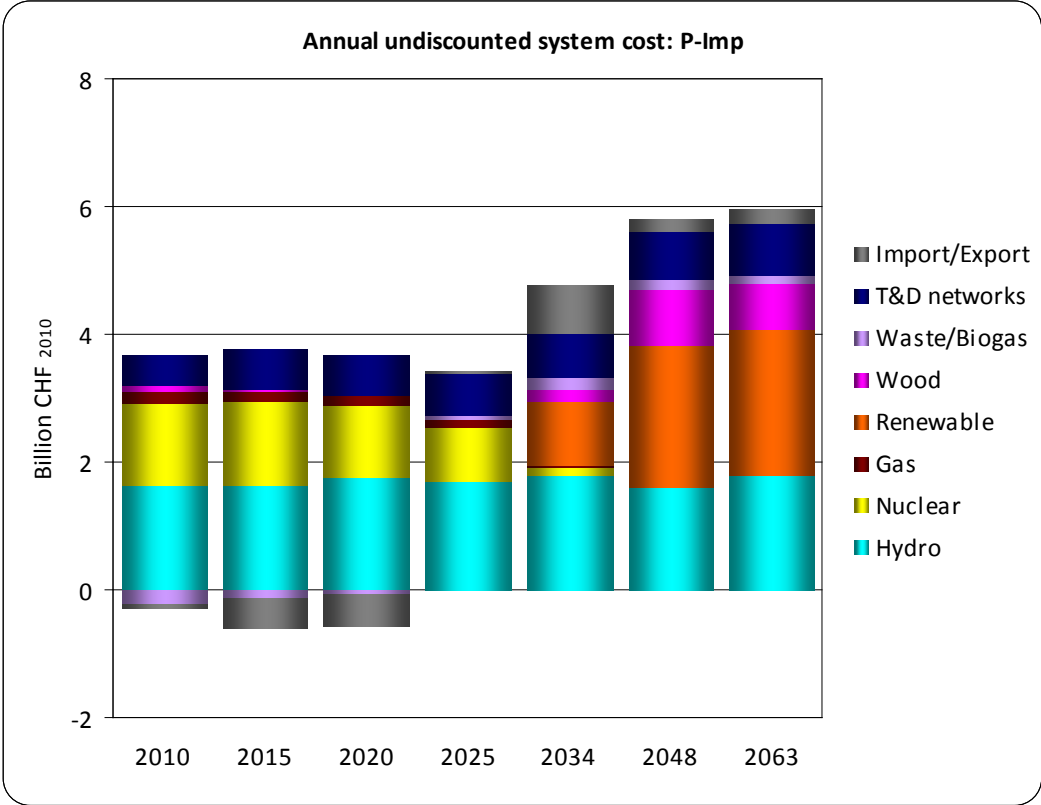


Fig. A-II-11: Annual undiscounted system cost by technology category – P-Imp

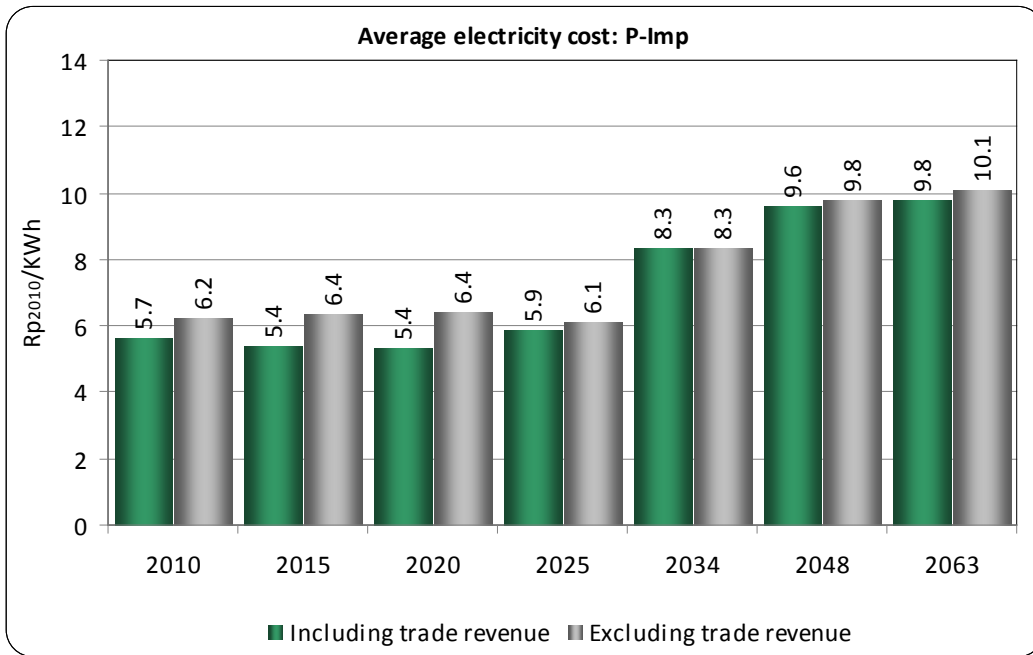


Fig. A-II-12: Average cost of electricity – P-Imp

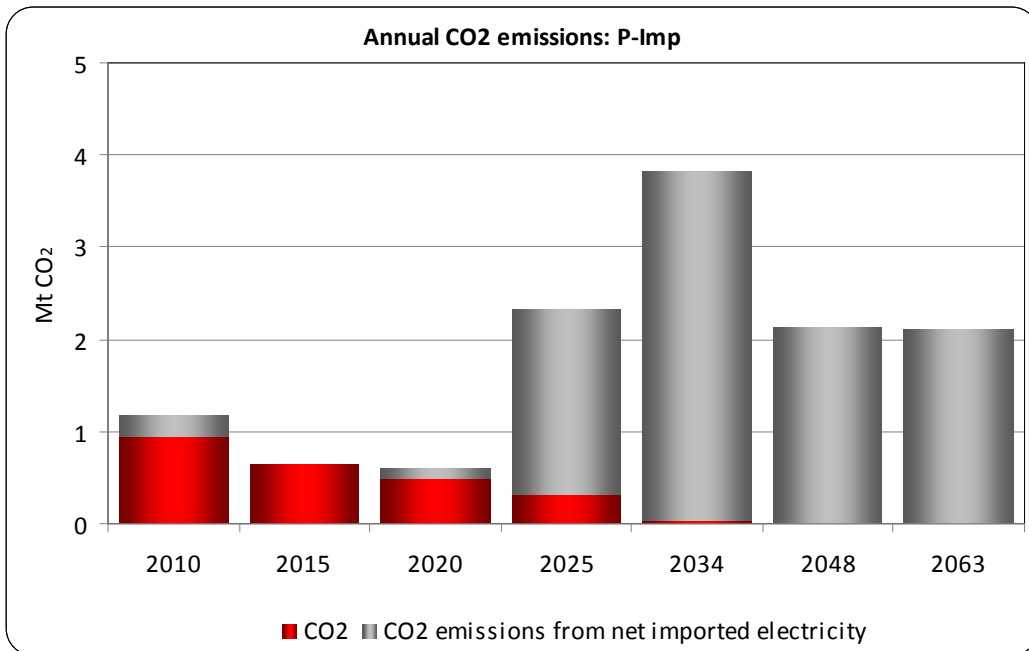


Fig. A-II-13: Annual CO₂ emissions – P-Imp

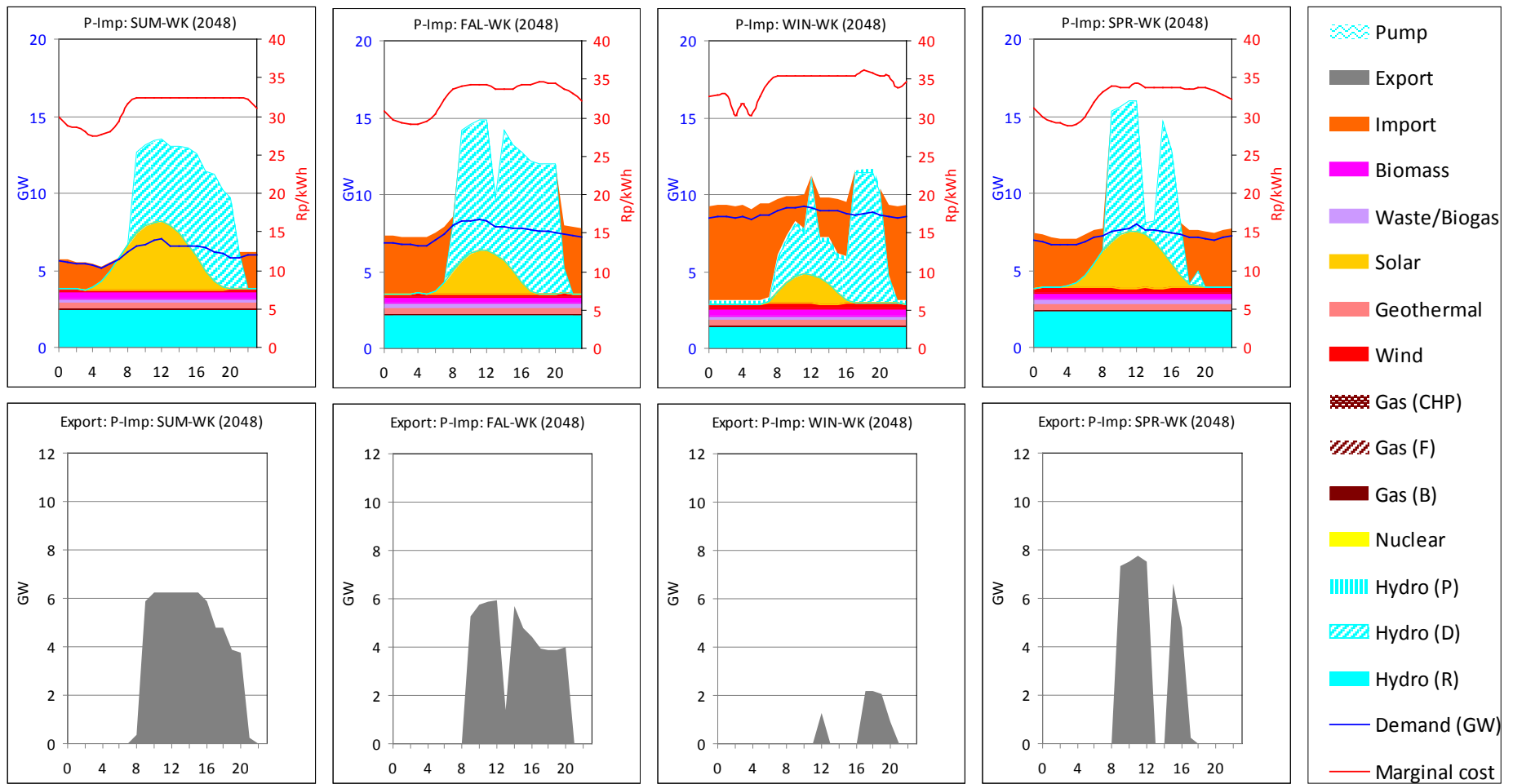


Fig. A-II-14: Electricity generation schedule on weekdays – P-Imp

Appendix III: POM demand and nuclear electricity supply (*P-Ref*)

Tab. A-III-9: Electricity generation mix: *P-Ref*

Electricity generation mix (PJ): *P-Ref*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			3	20		1	
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	95	82	63	87	91	101
Hydro	135	137	146	148	159	158	160
Renewable	9	8	8	8	5	8	5
Pumps	-9	-12	-15	-16	-28	-26	-29
Total	229	229	226	224	224	232	237

Renewable electricity generation (PJ): *P-Ref*

Geothermal							
Solar	0	0	0	0	0		
Wind	0	0	0	0	0		
Waste & Biogas	8	8	8	8	5	8	5
Wood	1						
Total renewable	9	8	8	8	5	8	5
Net electricity import, if any	2		0				

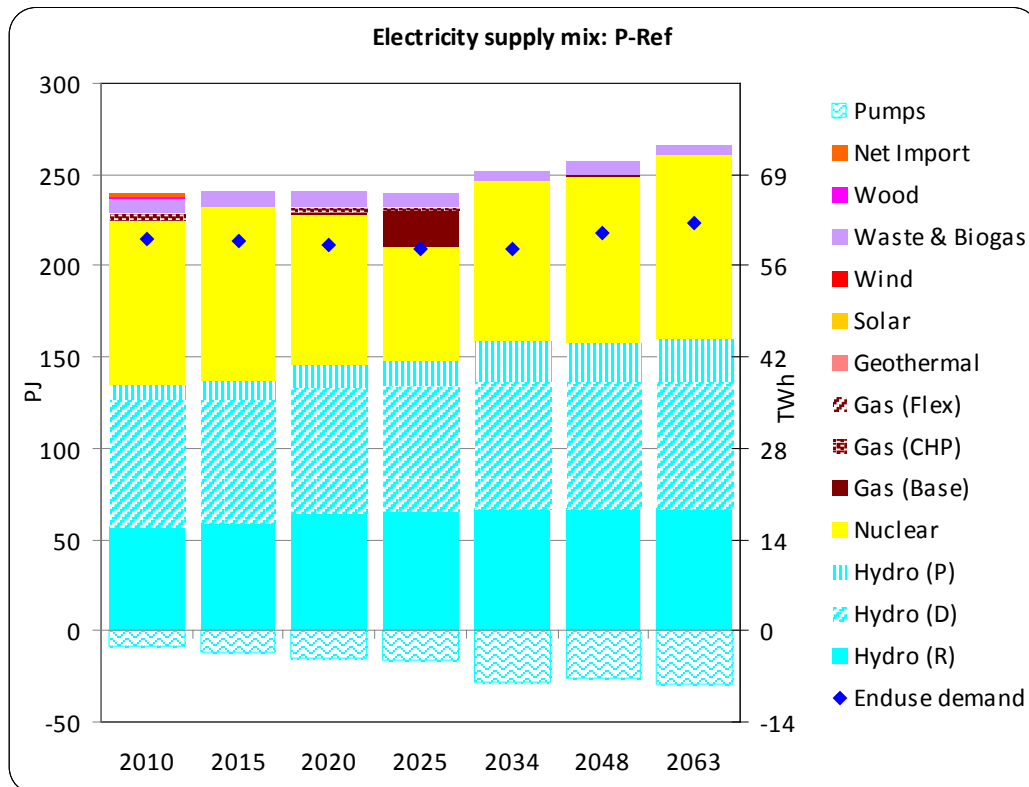


Fig. A-III-15: Electricity generation mix – *P-Ref*

Tab. A-III-10: Installed capacity – P-Ref

Installed Capacity (GW): P-Ref

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.4	1.1	1.1	0.4	
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	3.5	3.6	4.0
Hydro	13.1	13.5	14.2	14.0	15.4	15.7	16.1
Renewable	0.7	0.6	0.7	1.0	1.1	1.2	1.1
Total	17.3	17.6	18.3	18.3	21.0	20.8	21.2

Renewable Capacity (GW): P-Nuc

Geothermal							
Solar	0.0	0.0	0.0	0.0	0.0		
Wind	0.0	0.0	0.0	0.0	0.0		
Waste & Biogas	0.6	0.5	0.6	0.9	1.1	1.2	1.1
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	1.1	1.2	1.1

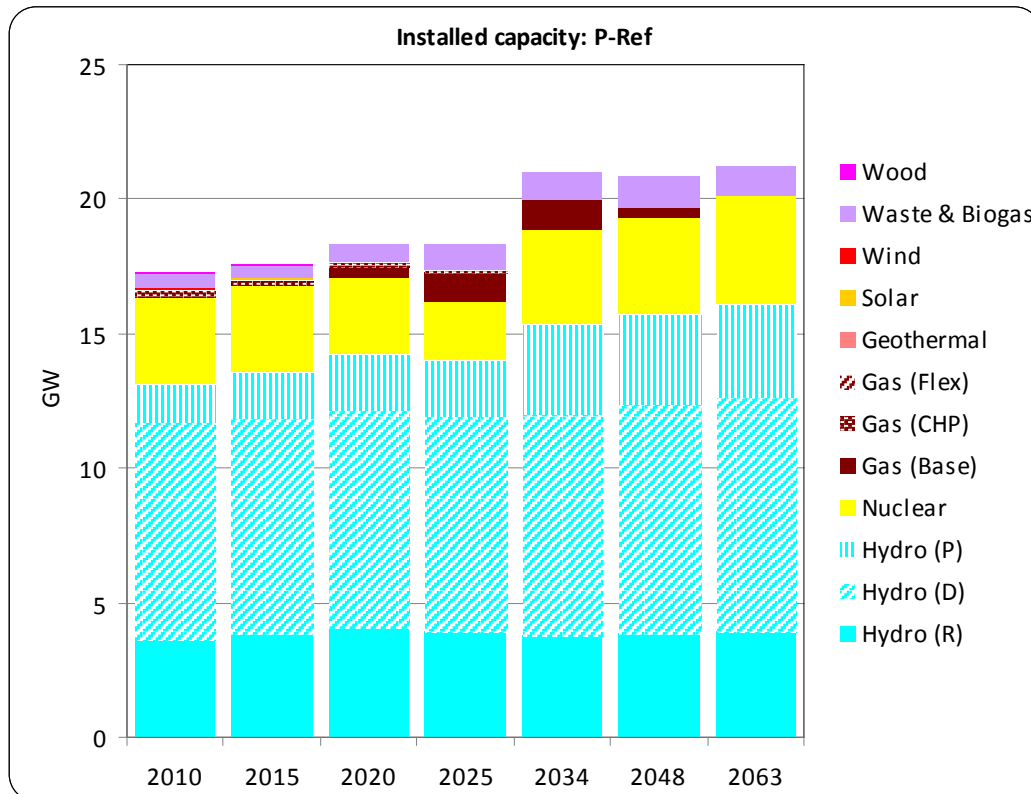


Fig. A-III-16: Installed capacity – P-Ref

Tab. A-III-11: Annual undiscounted system cost by category – P-Ref

Undiscounted system cost (Billion CHF₂₀₁₀): P-Ref

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.3	0.4	0.7	0.2	0.2	0.2
Capital	1.5	1.5	1.6	1.7	2.1	2.3	2.6
Variable O&M	0.8	0.7	0.7	0.8	0.7	0.7	0.7
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Trade Balance	-0.3	-0.5	-0.7	-0.9	-1.4	-1.3	-1.4
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.1	3.4	2.9	3.1	3.3

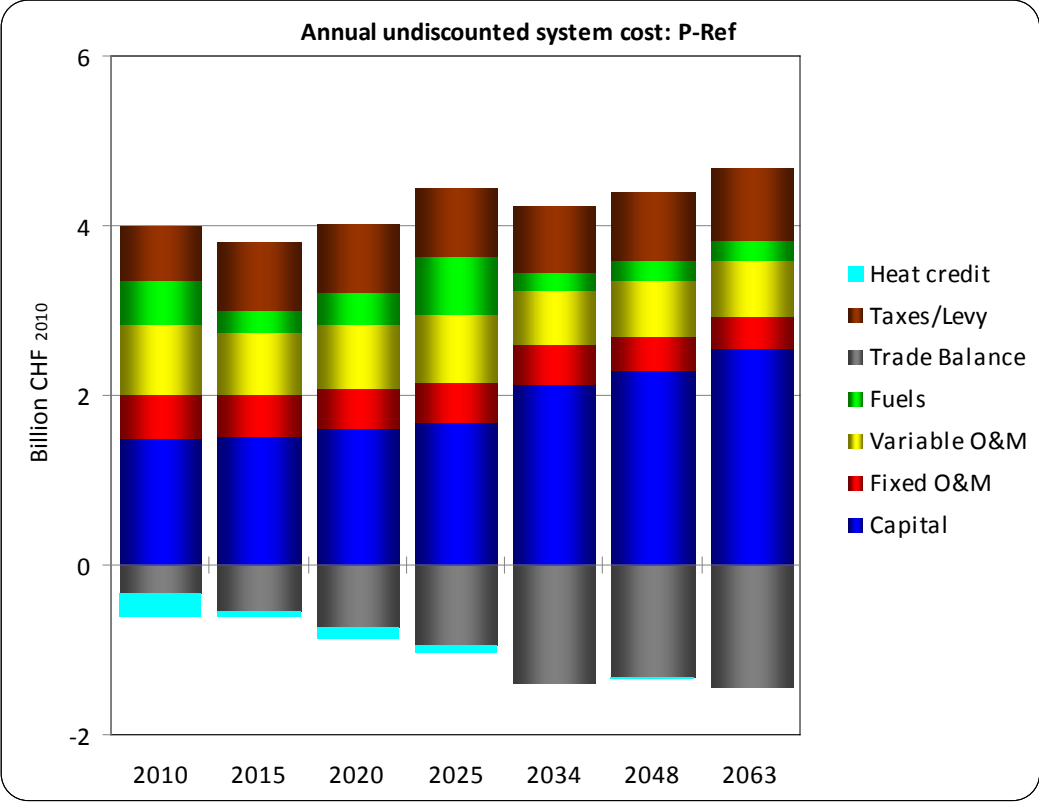


Fig. A-III-17: Annual undiscounted system cost by cost category – P-Ref

Tab. A-III-12: Annual undiscounted system cost by technology – *P-Ref*

Undiscounted system cost (Billion CHF₂₀₁₀): *P-Ref*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.9
Gas	0.2	0.0	0.2	0.9	0.1	0.0	
Nuclear	1.3	1.3	1.1	0.9	1.1	1.3	1.3
Renewable							
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.3	0.2
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.4	-0.6	-0.8	-1.1	-1.0	-1.0
Total	3.4	3.2	3.1	3.4	2.9	3.1	3.3

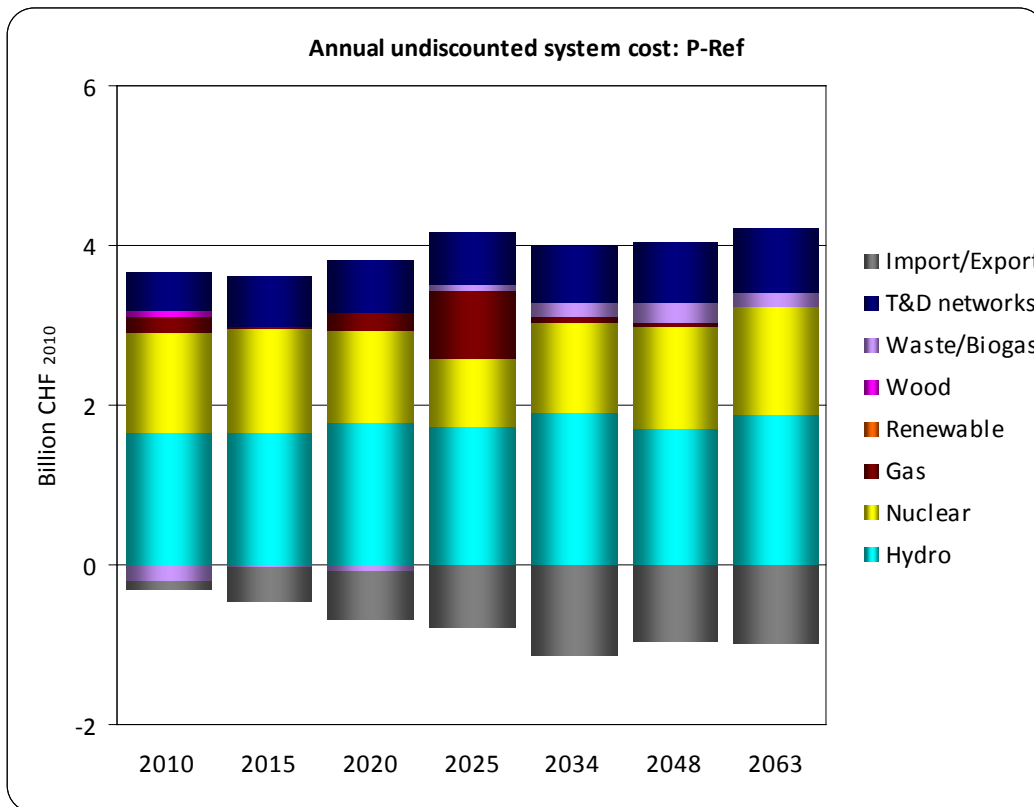


Fig. A-III-18: Annual undiscounted system cost by technology category – *P-Ref*

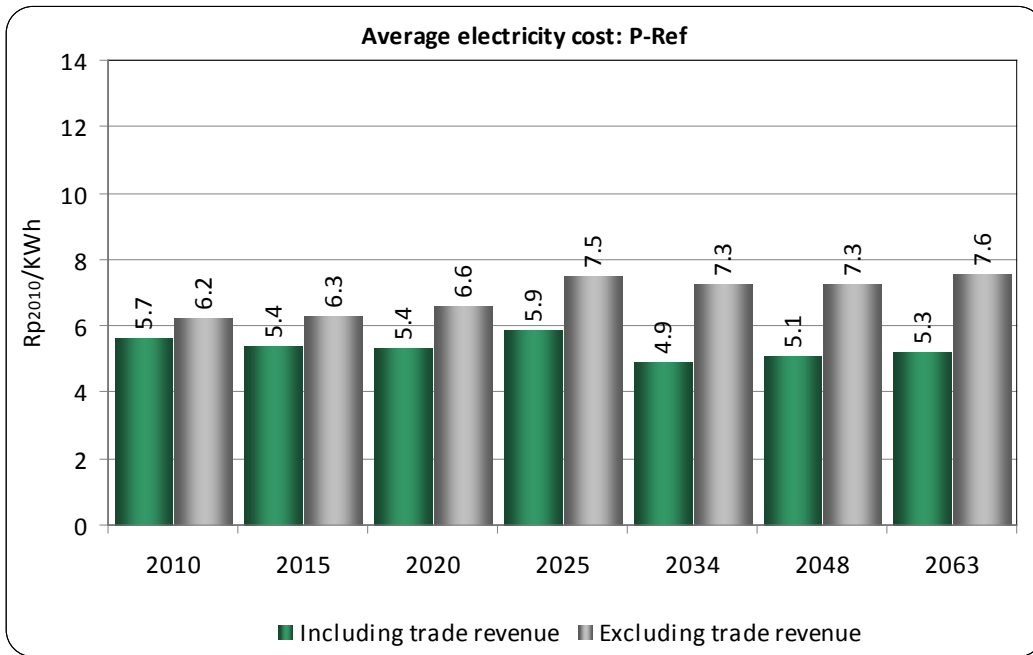


Fig. A-III-19: Average cost of electricity – P-Ref

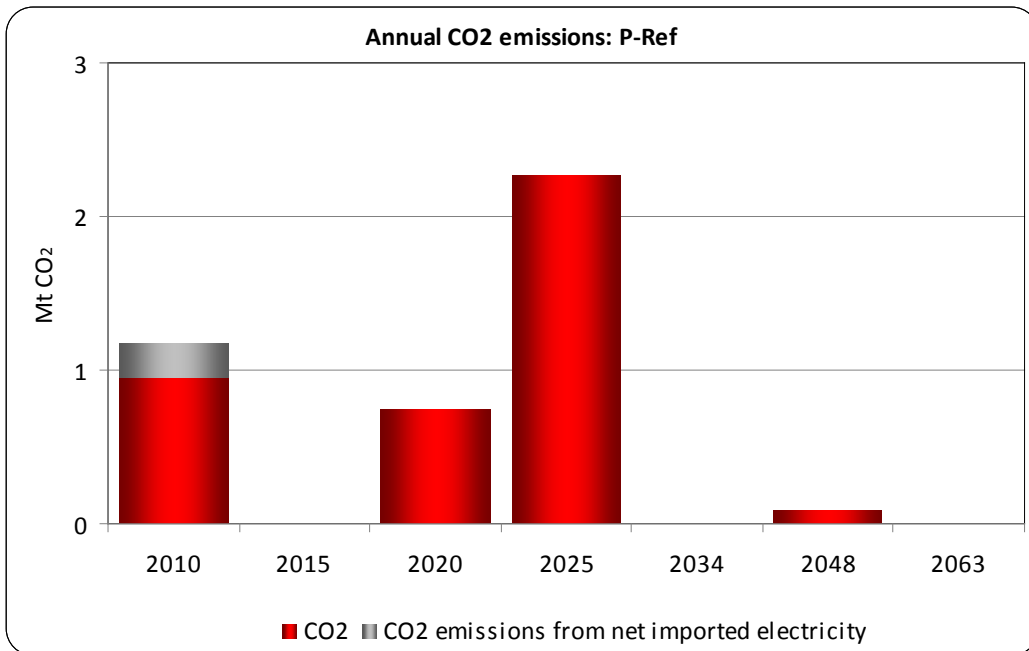


Fig. A-III-20: Annual CO₂ emissions – P-Ref

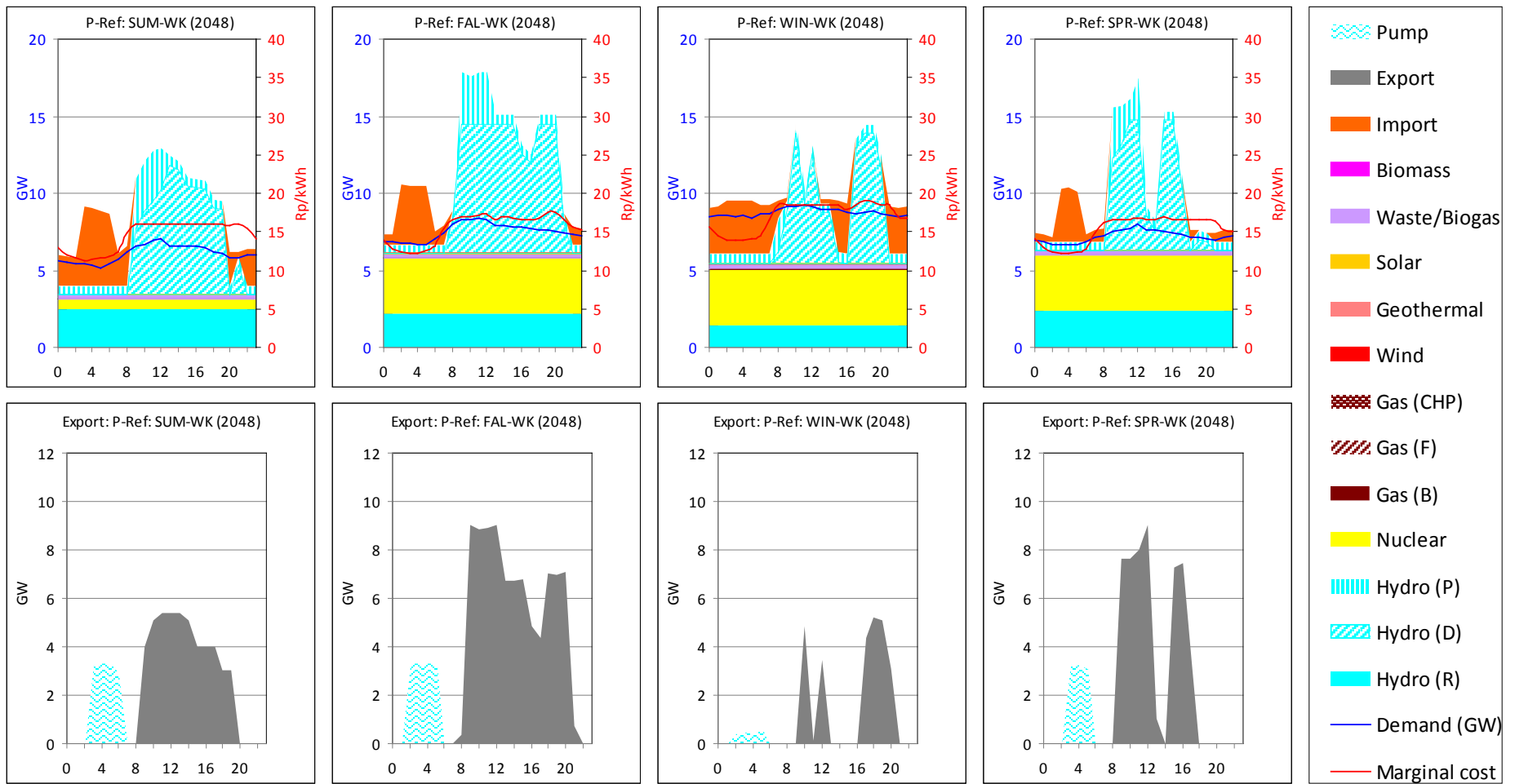


Fig. A-III-21: Electricity generation schedule on weekdays – P-Ref

Appendix IV: NEP demand and gas based electricity supply (N-Gas)

Tab. A-IV-13: Electricity generation mix: N-Gas

Electricity generation mix (PJ): N-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			1	14	33	7	
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	94	82	63	14		
Hydro	135	134	142	143	145	146	145
Renewable	9	8	8	9	35	62	68
Pumps	-9	-8	-11	-10	-11	-10	-10
Total	229	228	225	220	217	205	203

Renewable electricity generation (PJ): N-Gas

Geothermal				1	4	12	16
Solar	0	0	0	0	19	33	35
Wind	0	0	0	0	4	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	9	35	62	68
Net electricity import, if any	2		0	0			

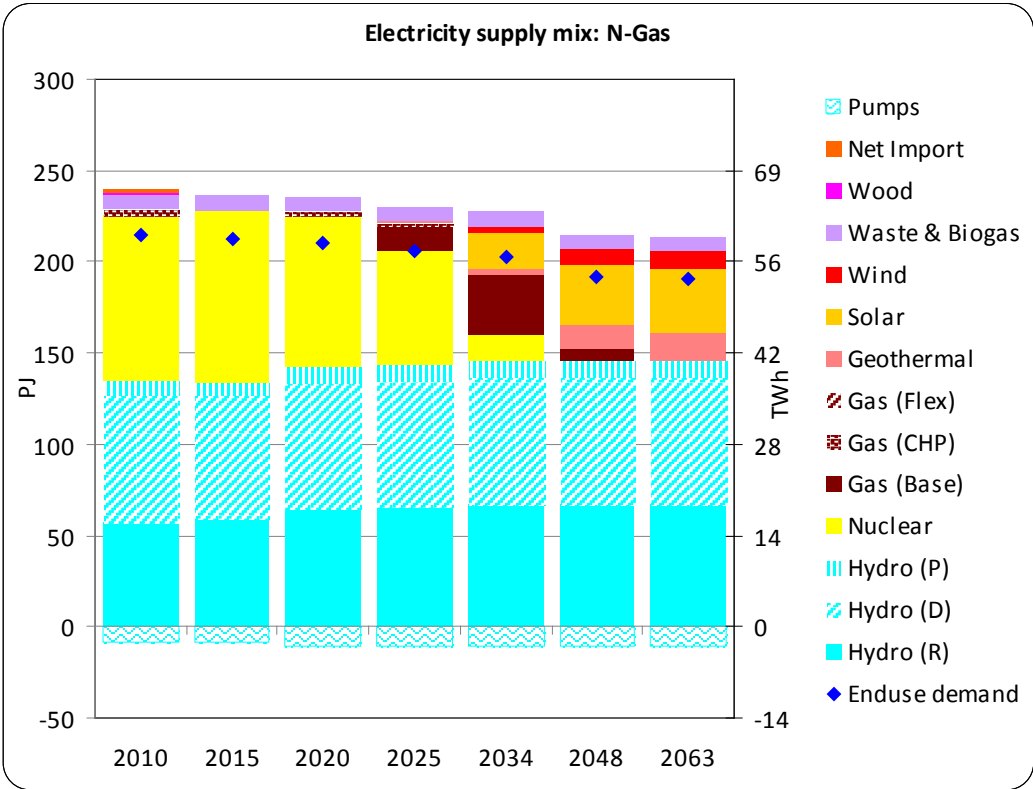


Fig. A-IV-22: Electricity generation mix – N-Gas

Tab. A-IV-14: Installed capacity (GW): N-Gas

Installed Capacity (GW): N-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.2	0.6	1.4	1.3	0.1
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.4	13.8	13.6	13.7	14.0	14.0
Renewable	0.7	0.6	0.7	1.0	7.8	13.2	14.1
Total	17.3	17.4	17.7	17.4	23.3	28.5	28.2

Renewable Capacity (GW): N-Gas

Geothermal				0	0	0	1
Solar	0.0	0.0	0.0	0.0	5.5	9.6	10.2
Wind	0.0	0.0	0.0	0.0	0.9	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	7.8	13.2	14.1

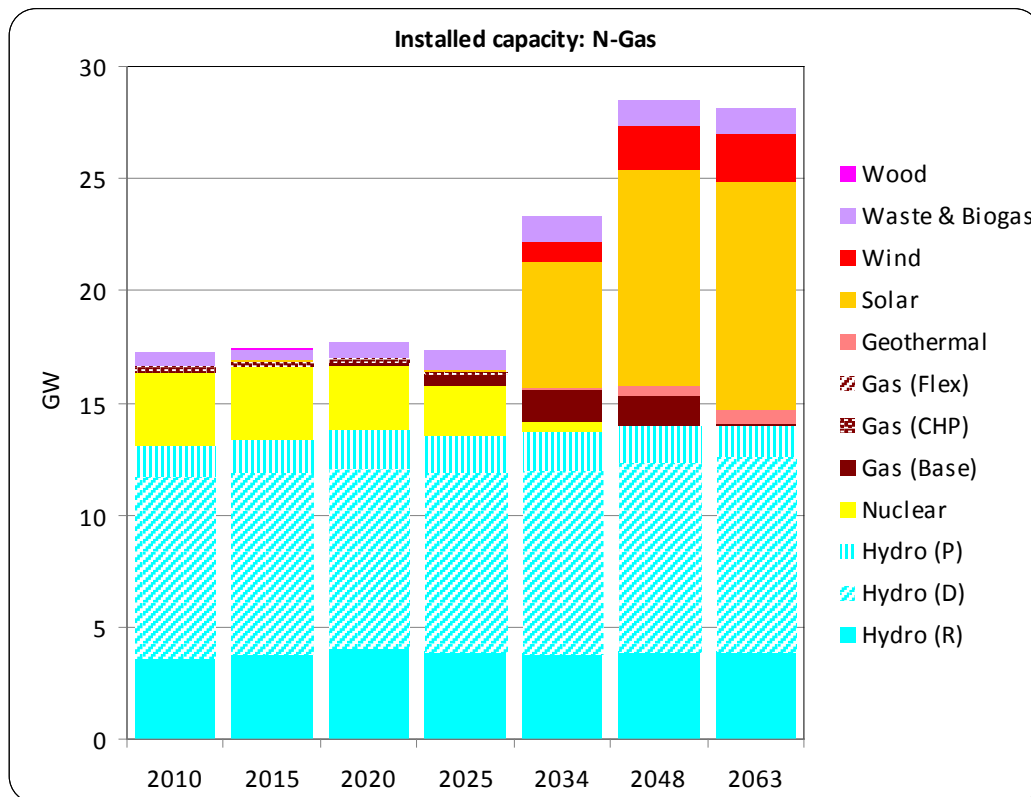


Fig. A-IV-23: Installed capacity – N-Gas

Tab. A-IV-15: Annual undiscounted system cost by category – N-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): N-Gas

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.2	0.4	0.6	0.8	0.2	0.0
Capital	1.5	1.5	1.6	1.7	2.5	3.4	3.7
Variable O&M	0.8	0.7	0.7	0.8	0.8	0.7	0.7
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.8	0.9	0.6	0.5
Trade Balance	-0.3	-0.5	-0.7	-0.9	-1.1	-1.1	-1.1
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.1	3.3	4.5	4.3	4.3

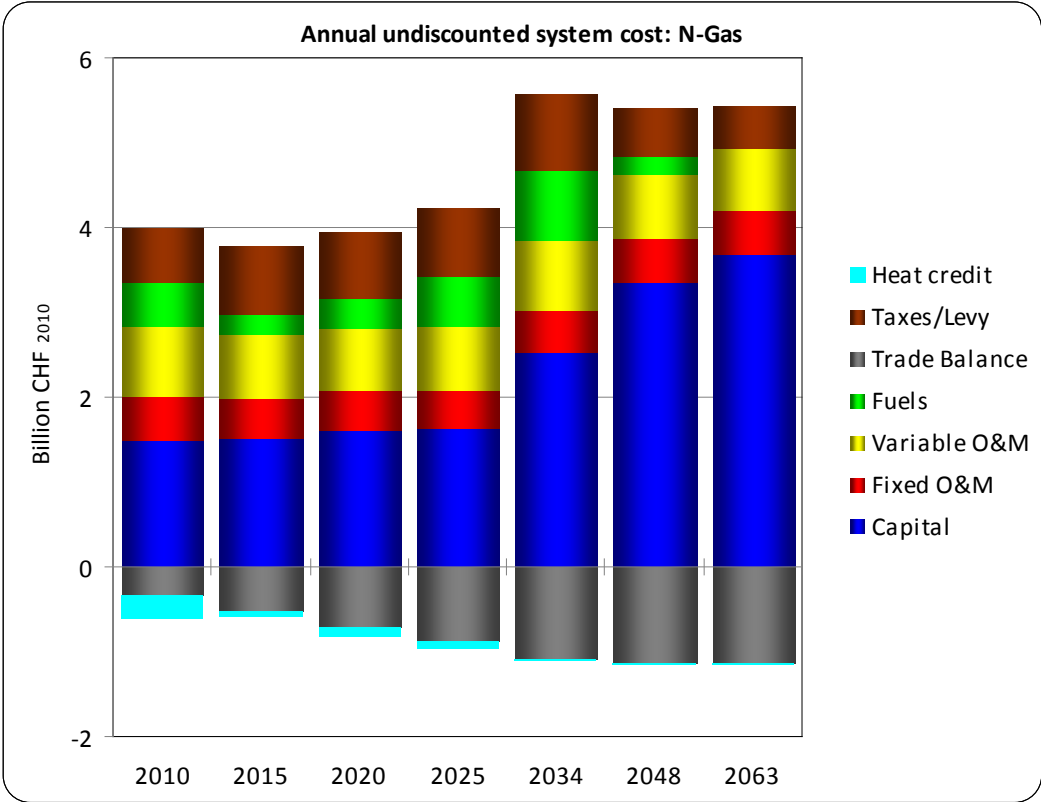


Fig. A-IV-24: Annual undiscounted system cost by cost category – N-Gas

Tab. A-IV-16: Annual undiscounted system cost by technology – N-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): N-Gas

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.6	1.8
Gas	0.2	0.0	0.2	0.7	1.5	0.4	0.0
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	1.0	2.1	2.3
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Import/Export	-0.1	-0.4	-0.6	-0.7	-0.9	-0.8	-0.7
Total	3.4	3.2	3.1	3.3	4.5	4.3	4.3

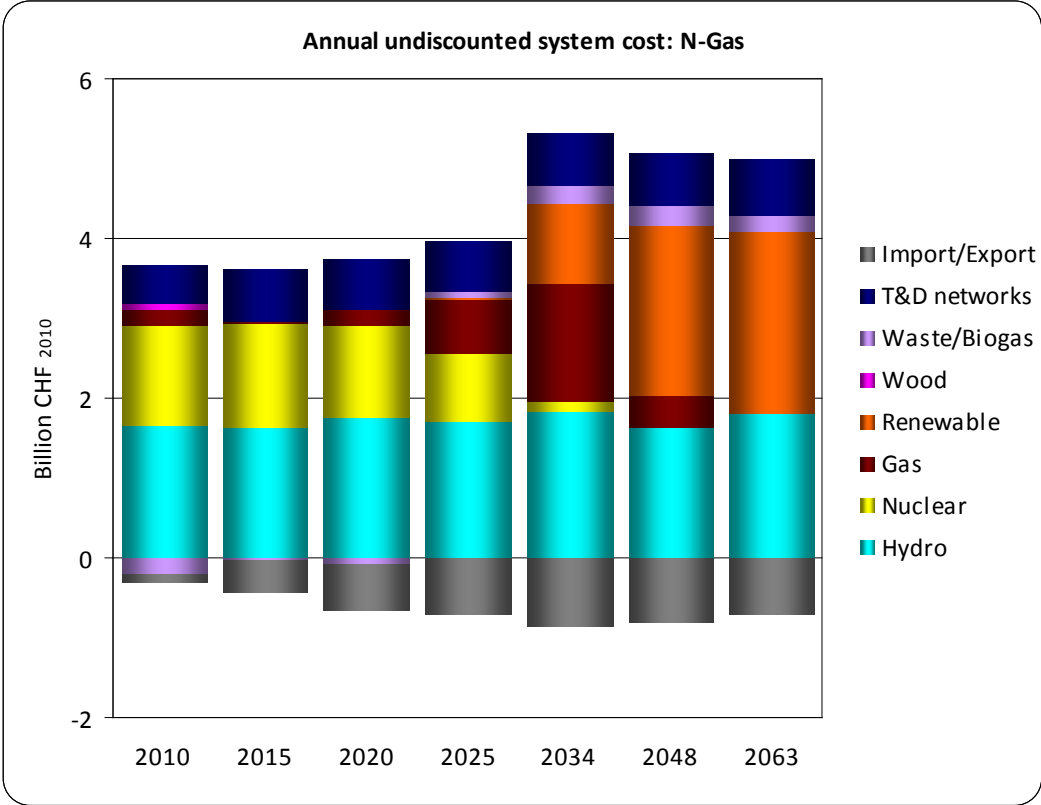


Fig. A-IV-25: Annual undiscounted system cost by technology category – N-Gas

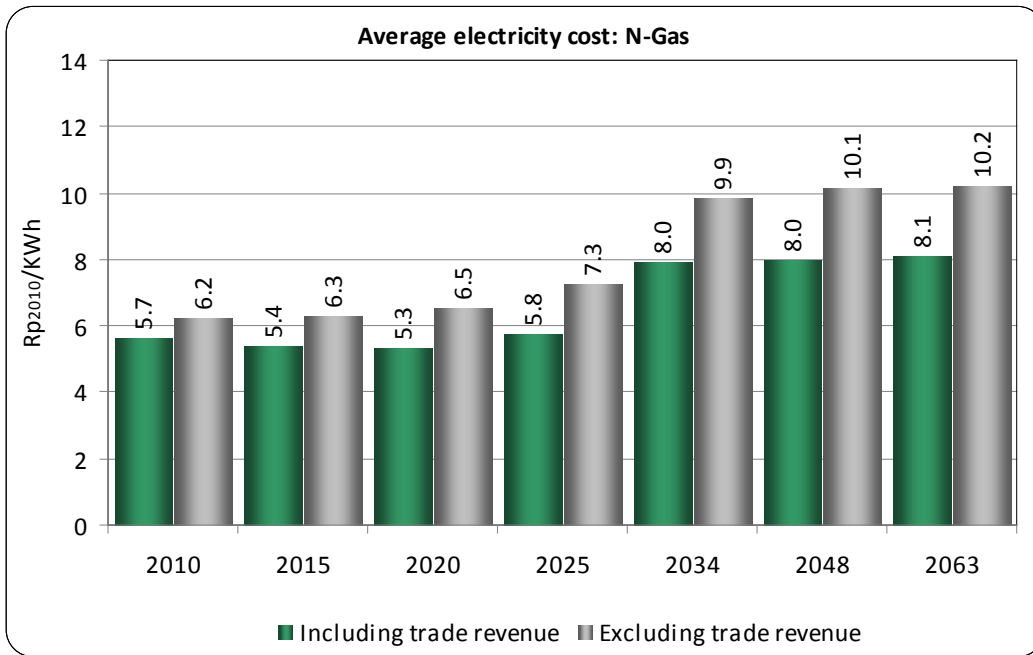


Fig. A-IV-26: Average cost of electricity – N-Gas

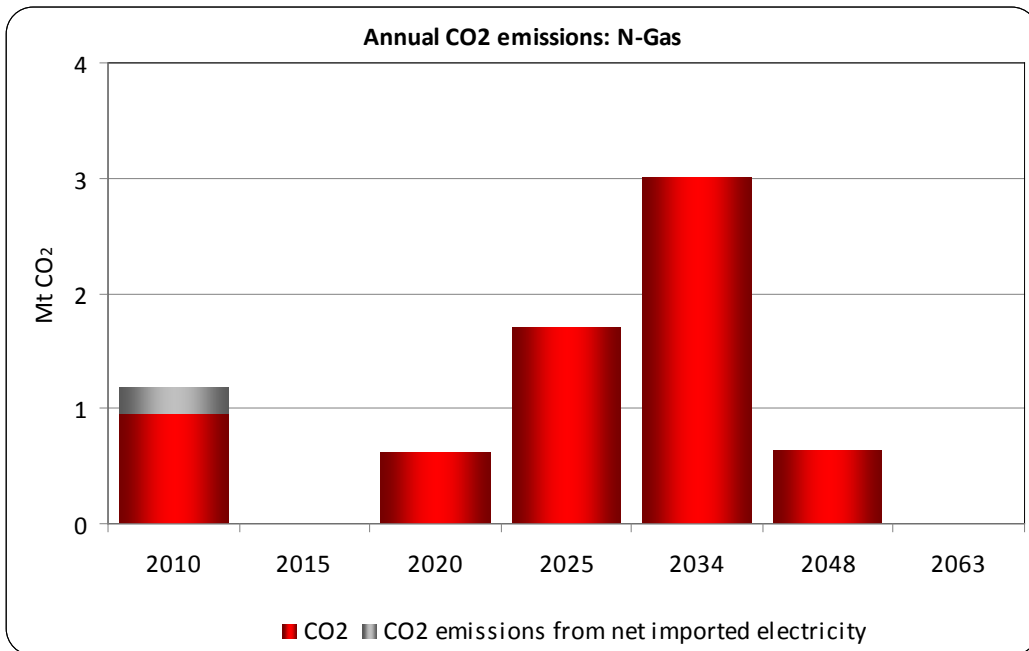


Fig. A-IV-27: Annual CO₂ emissions – N-Gas

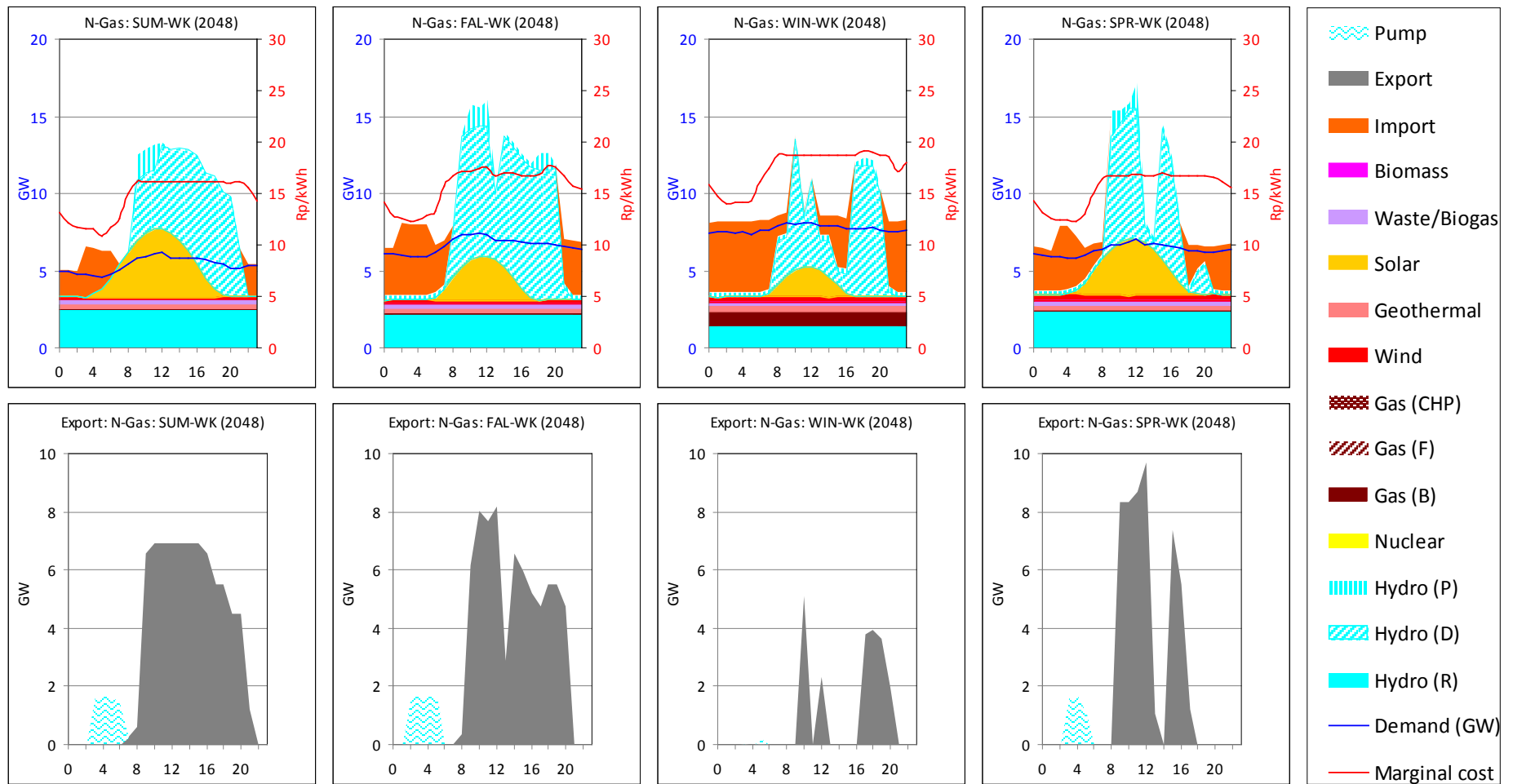


Fig. A-IV-28: Electricity generation schedule on weekdays – N-Gas

Appendix V: NEP demand and import/renewable electricity supply (N-Imp)

Tab. A-V-17: Electricity generation mix: N-Imp

Electricity generation mix (PJ): N-Imp

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	3	3	2	1	0		
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	131	139	140	139	139	144
Renewable	9	8	8	8	39	68	68
Pumps	-9	-4	-6	-6	-2	-2	-9
Total	229	233	225	206	189	205	203

Renewable electricity generation (PJ): N-Imp

Geothermal					4	14	15
Solar	0	0	0	0	19	33	35
Wind	0	0	0	0	4	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1				4	4	1
Total renewable	9	8	8	8	39	68	68
Net electricity import, if any	2		0	13	26		

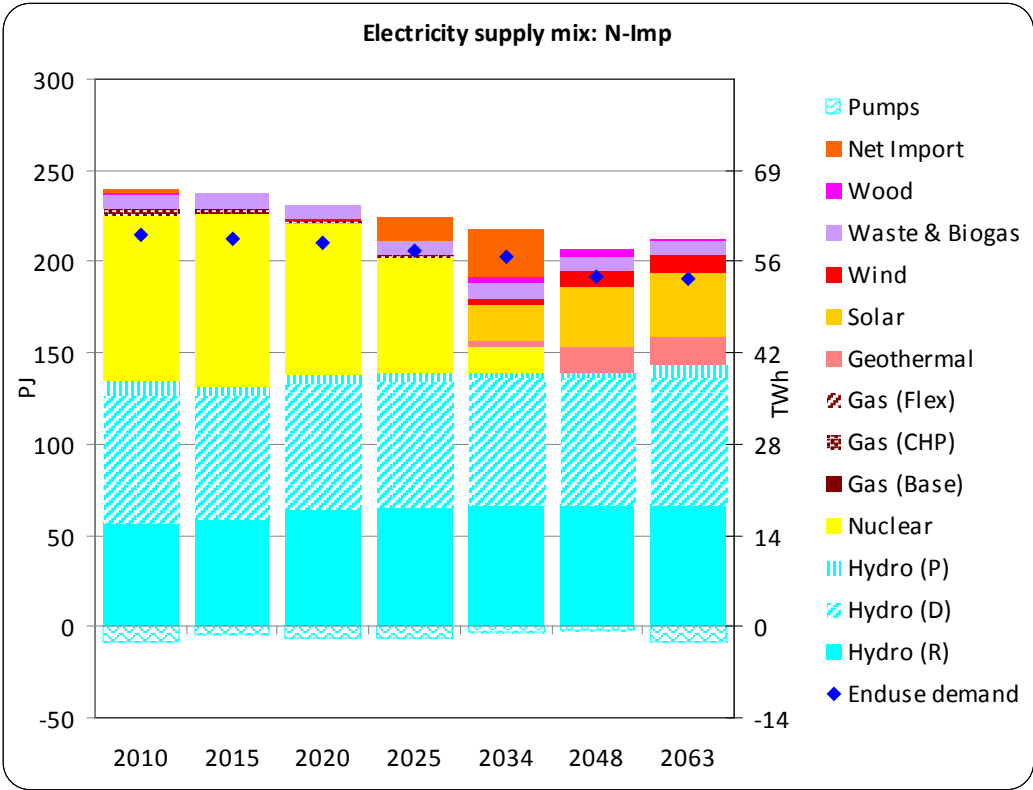


Fig. A-V-29: Electricity generation mix – N-Imp

Tab. A-V-18: Installed capacity – *N-Imp*

Installed Capacity (GW): *N-Imp*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.3	13.6	13.4	13.5	13.8	13.8
Renewable	0.7	0.6	0.7	1.0	8.0	13.5	14.1
Total	17.3	17.3	17.3	16.6	22.0	27.3	27.9

Renewable Capacity (GW): *N-Imp*

Geothermal					0	1	1
Solar	0.0	0.0	0.0	0.0	5.5	9.6	10.2
Wind	0.0	0.0	0.0	0.0	0.9	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.2	0.2	0.0
Total renewable	0.7	0.6	0.7	1.0	8.0	13.5	14.1

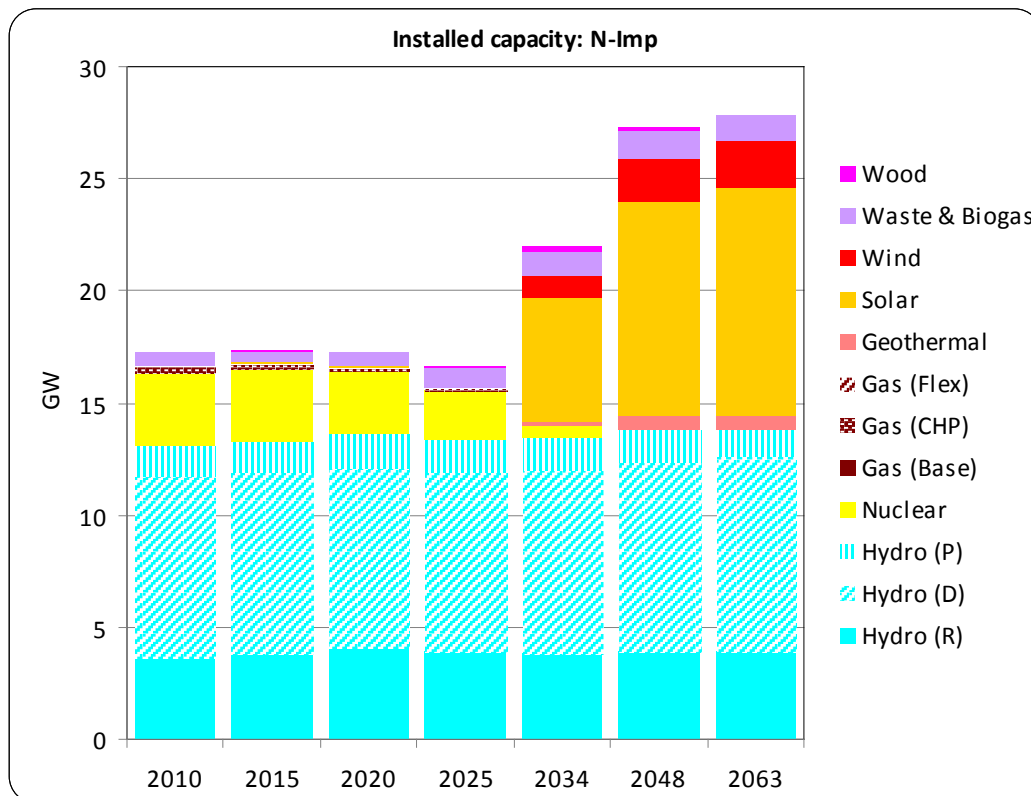


Fig. A-V-30: Installed capacity – *N-Imp*

Tab. A-V-19: Annual undiscounted system cost by category – N-Imp

Undiscounted system cost (Billion CHF₂₀₁₀): N-Imp

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.3	0.2	0.2	0.1	0.0
Capital	1.5	1.5	1.6	1.6	2.5	3.4	3.6
Variable O&M	0.8	0.7	0.7	0.6	0.6	0.7	0.7
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.7	0.5	0.5	0.5
Trade Balance	-0.3	-0.6	-0.6	-0.2	0.4	-1.0	-1.1
Heat credit	-0.3	-0.2	-0.1	-0.1	-0.1	0.0	0.0
Total cost	3.4	3.2	3.1	3.3	4.6	4.3	4.2

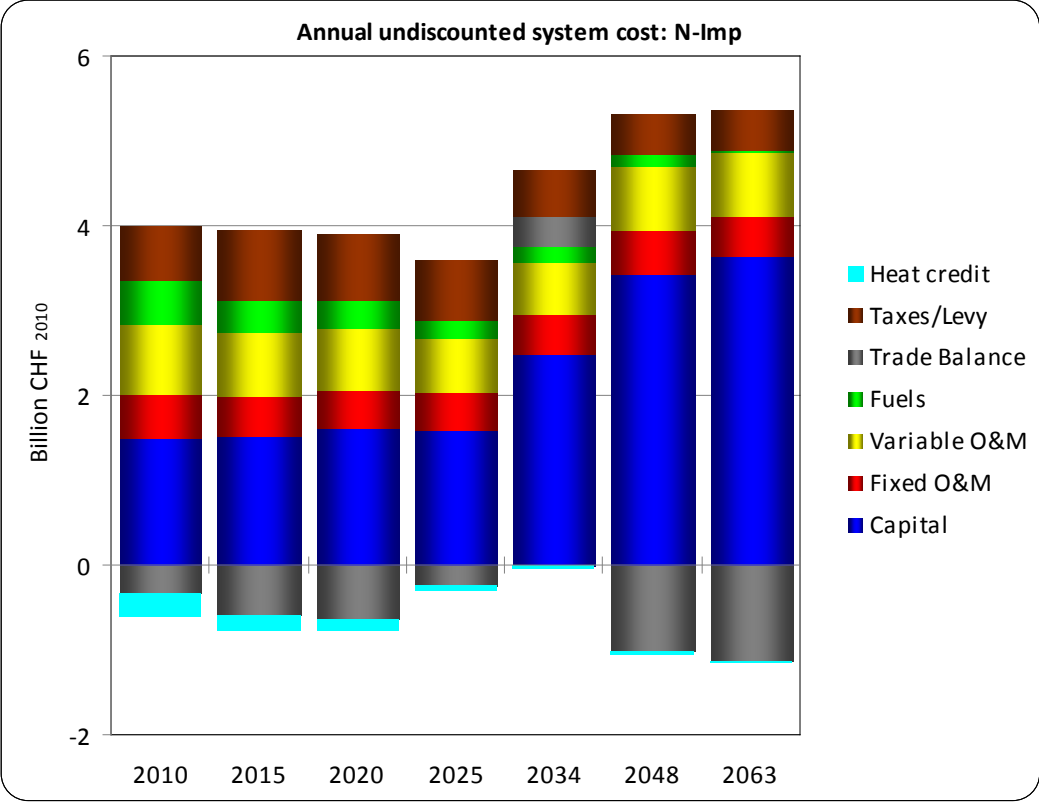


Fig. A-V-31: Annual undiscounted system cost by cost category – N-Imp

Tab. A-V-20: Annual undiscounted system cost by technology – *N-Imp*

Undiscounted system cost (Billion CHF₂₀₁₀): *N-Imp*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.6	1.8
Gas	0.2	0.2	0.1	0.1	0.0		
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	1.0	2.2	2.2
Wood	0.1	0.0	0.0	0.0	0.2	0.2	0.0
Waste/Biogas	-0.2	-0.1	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Import/Export	-0.1	-0.5	-0.5	-0.1	0.5	-0.7	-0.7
Total	3.4	3.2	3.1	3.3	4.6	4.3	4.2

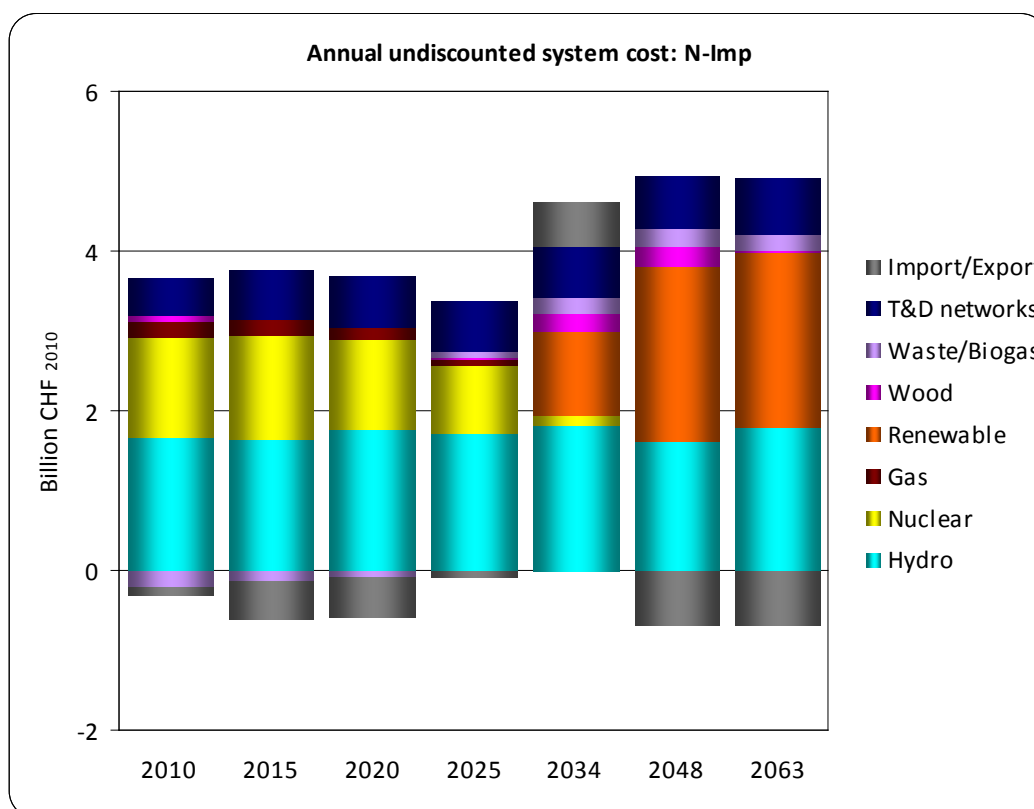


Fig. A-V-32: Annual undiscounted system cost by technology category – *N-Imp*

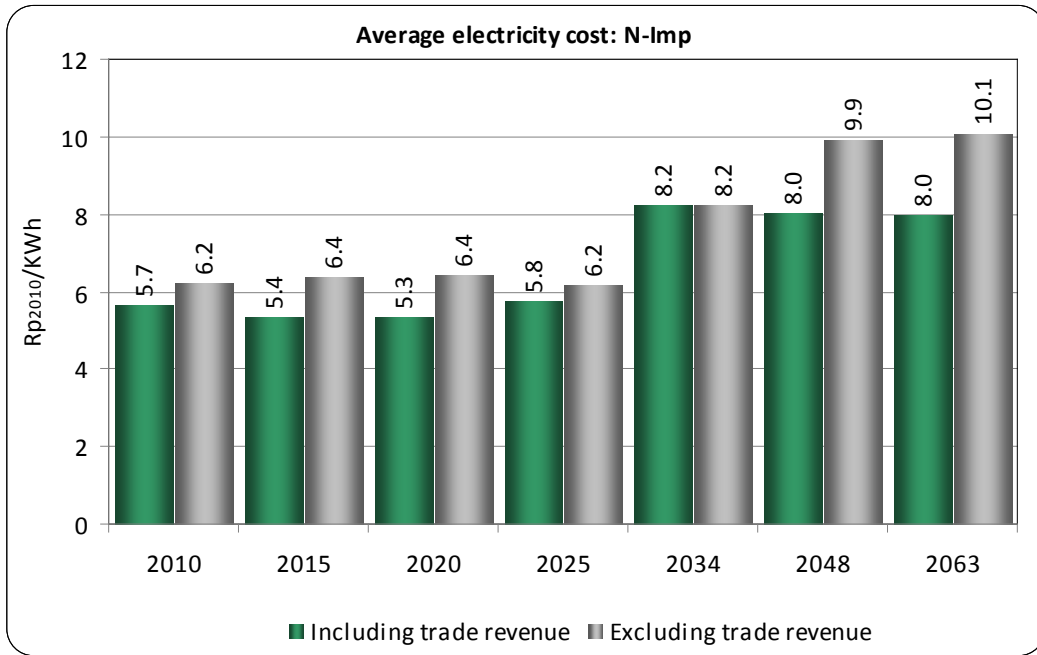


Fig. A-V-33: Average cost of electricity – *N-Imp*

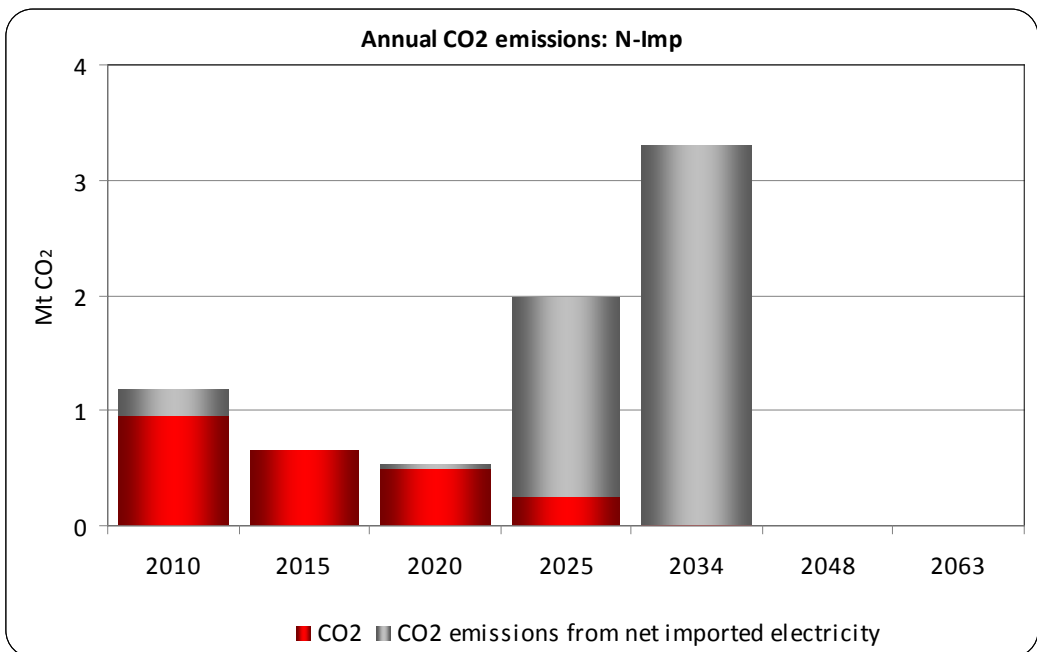


Fig. A-V-34: Annual CO₂ emissions – *N-Imp*

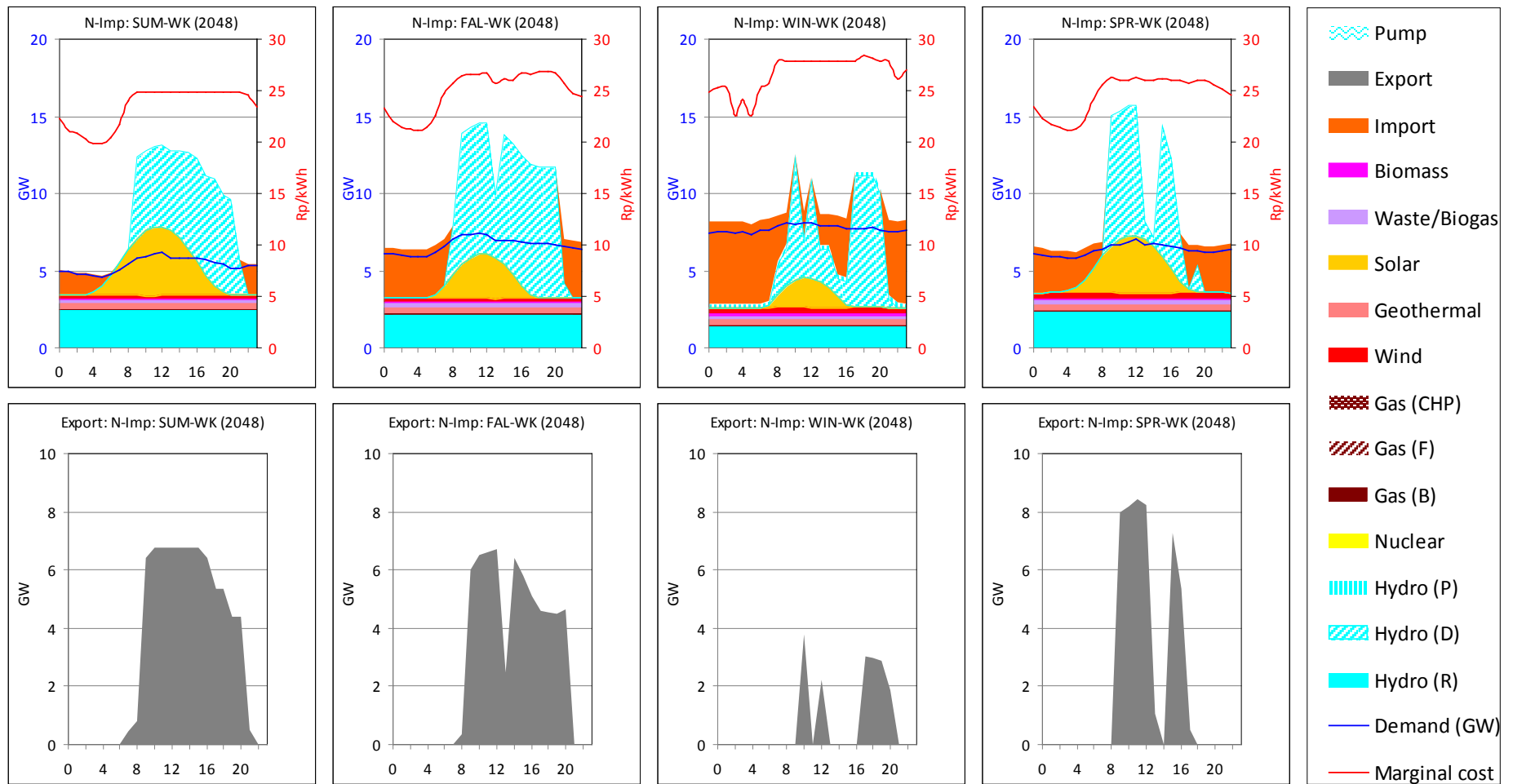


Fig. A-V-35: Electricity generation schedule on weekdays – N-Imp

Appendix VI: NEP demand and nuclear electricity supply (N-Ref)

Tab. A-VI-21: Electricity generation mix: N-Ref

Electricity generation mix (PJ): N-Ref

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			1	14			
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	94	82	63	85	72	71
Hydro	135	134	142	140	159	160	160
Renewable	9	8	8	8	5	5	5
Pumps	-9	-8	-11	-6	-28	-28	-29
Total	229	228	225	220	222	209	208

Renewable electricity generation (PJ): N-Ref

Geothermal							
Solar	0	0	0	0	0		
Wind	0	0	0	0	0		
Waste & Biogas	8	8	8	8	5	5	5
Wood	1						
Total renewable	9	8	8	8	5	5	5
Net electricity import, if any	2		0		0		

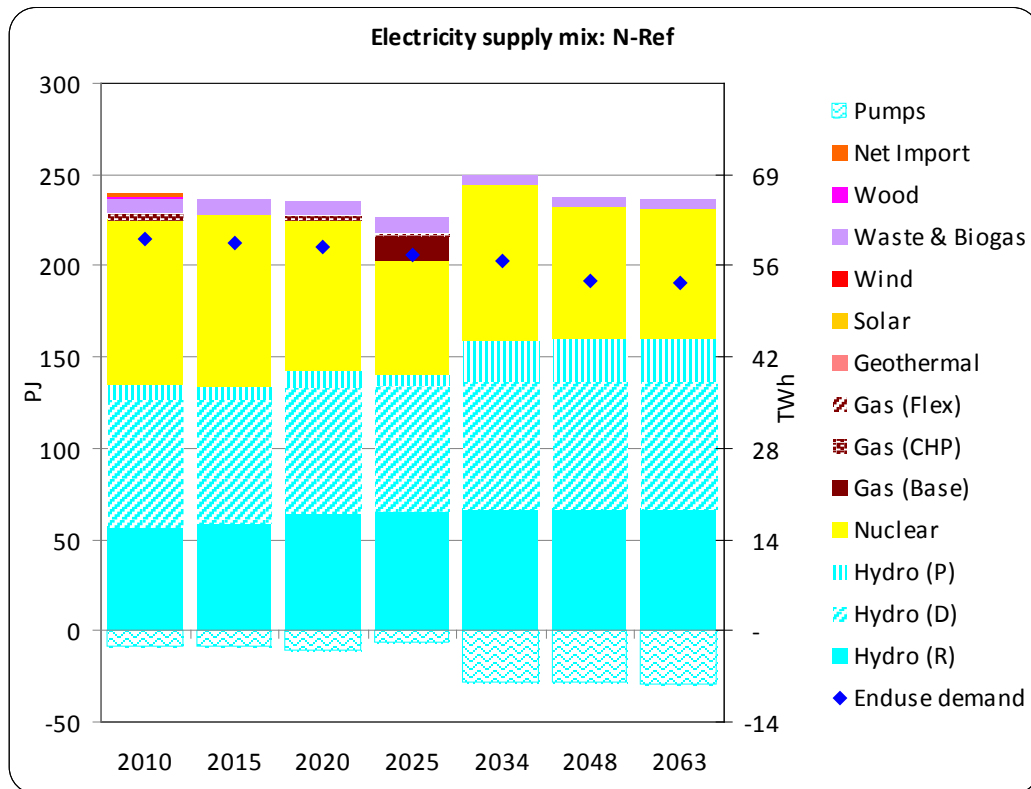


Fig. A-VI-36: Electricity generation mix – N-Ref

Tab. A-VI-22: Installed capacity – N-Ref

Installed Capacity (GW): N-Ref

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.2	0.6	0.6	0.2	
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	3.5	3.0	3.0
Hydro	13.1	13.4	13.8	13.6	15.3	15.8	16.1
Renewable	0.7	0.6	0.7	1.0	1.1	1.1	1.1
Total	17.3	17.4	17.7	17.4	20.4	20.1	20.2

Renewable Capacity (GW): N-Ref

Geothermal							
Solar	0.0	0.0	0.0	0.0	0.0		
Wind	0.0	0.0	0.0	0.0	0.0		
Waste & Biogas	0.6	0.5	0.6	0.9	1.1	1.1	1.1
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	1.1	1.1	1.1

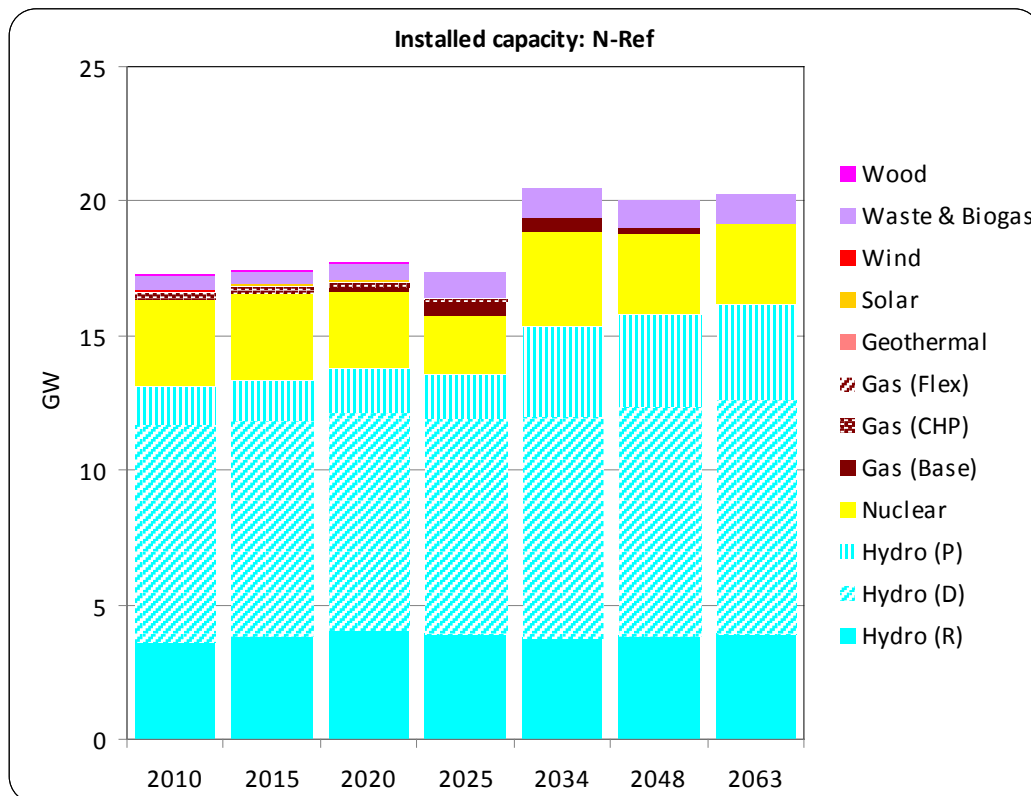


Fig. A-VI-37: Installed capacity – N-Ref

Tab. A-VI-23: Annual undiscounted system cost by category – N-Ref

Undiscounted system cost (Billion CHF₂₀₁₀): N-Ref

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.2	0.4	0.6	0.2	0.2	0.2
Capital	1.5	1.5	1.6	1.7	2.1	2.1	2.4
Variable O&M	0.8	0.7	0.7	0.7	0.6	0.6	0.6
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.8	0.7	0.7
Trade Balance	-0.3	-0.5	-0.7	-0.8	-1.4	-1.4	-1.5
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0		
Total cost	3.4	3.2	3.1	3.3	2.8	2.5	2.8

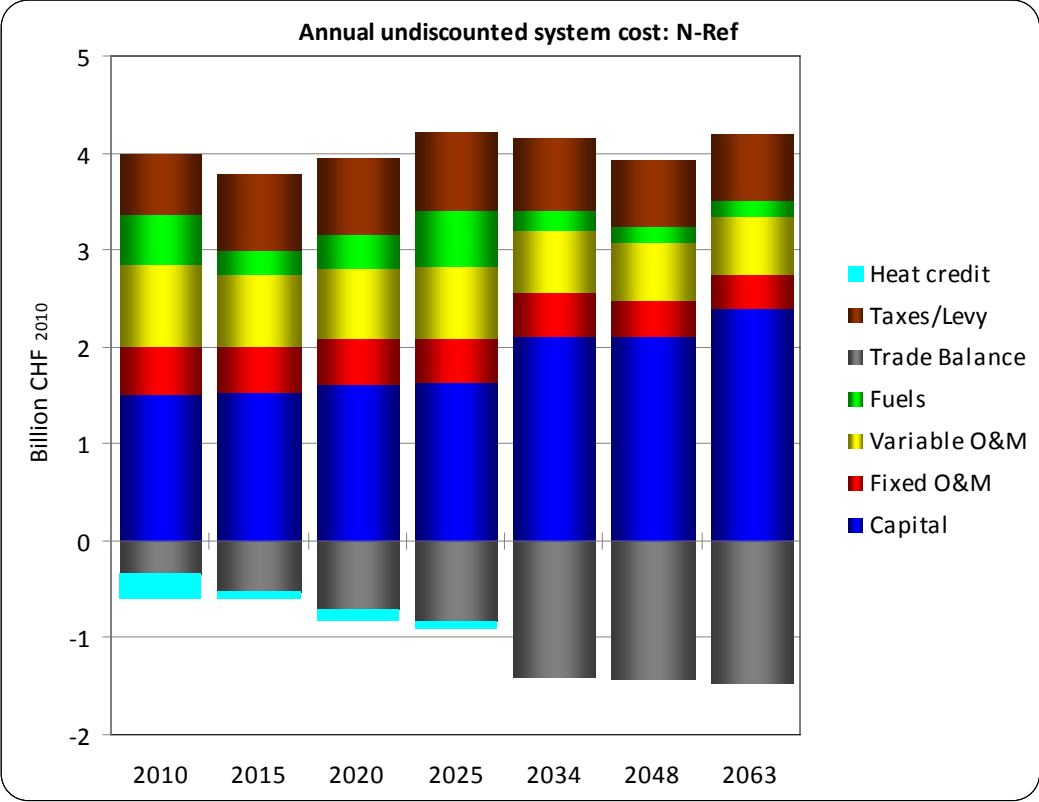


Fig. A-VI-38: Annual undiscounted system cost by cost category – N-Ref

Tab. A-VI-24: Annual undiscounted system cost by technology – N-Ref

Undiscounted system cost (Billion CHF₂₀₁₀): N-Ref

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.9
Gas	0.2	0.0	0.2	0.7	0.0	0.0	0.0
Nuclear	1.3	1.3	1.1	0.9	1.1	1.0	1.0
Renewable							
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Import/Export	-0.1	-0.4	-0.6	-0.7	-1.2	-1.1	-1.0
Total	3.4	3.2	3.1	3.3	2.8	2.5	2.8

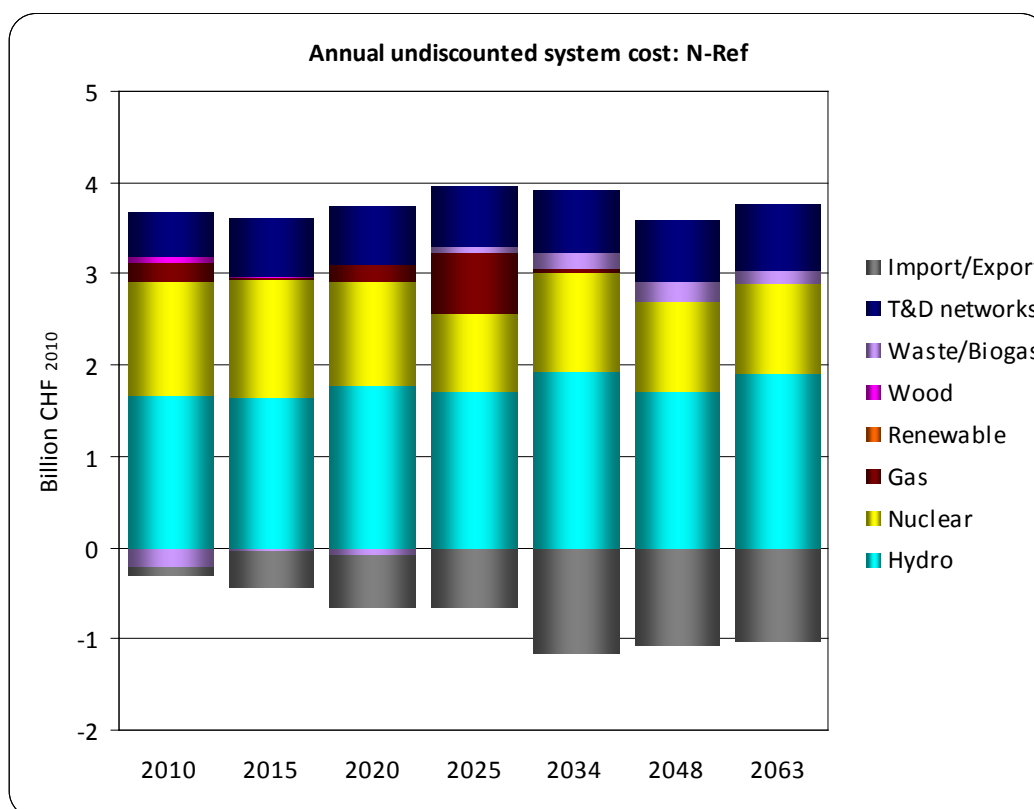


Fig. A-VI-39: Annual undiscounted system cost by technology category – N-Ref

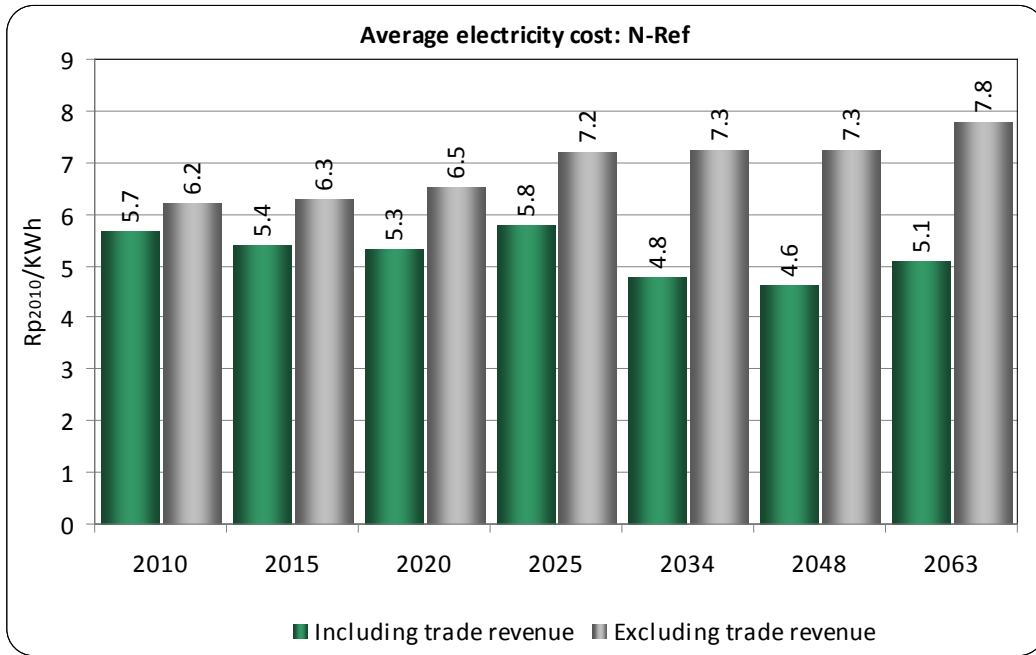


Fig. A-VI-40: Average cost of electricity – N-Ref

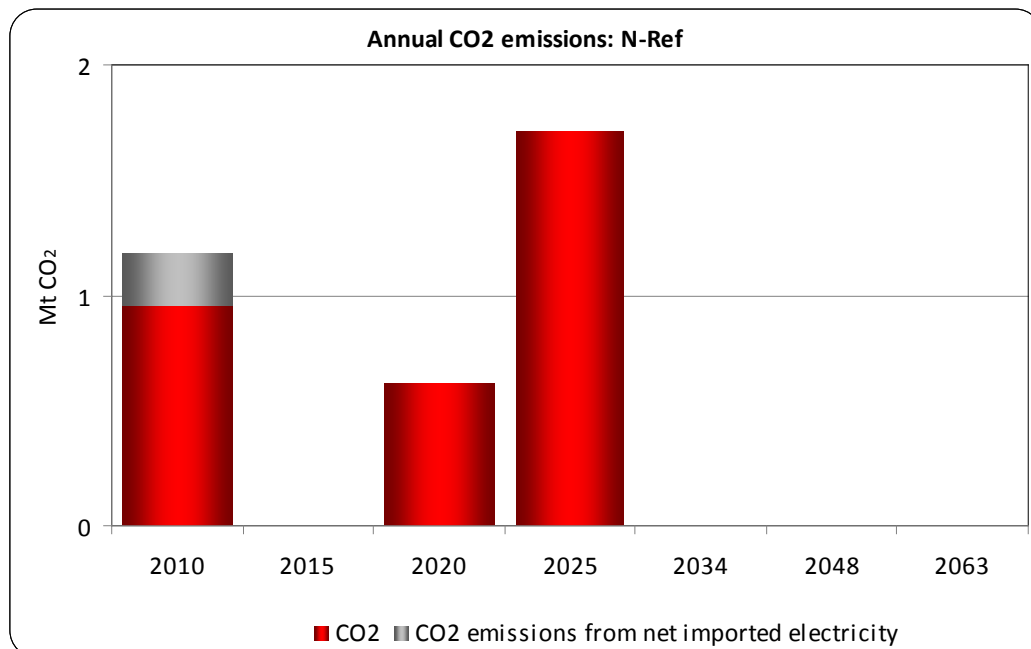


Fig. A-VI-41: Annual CO₂ emissions – N-Ref

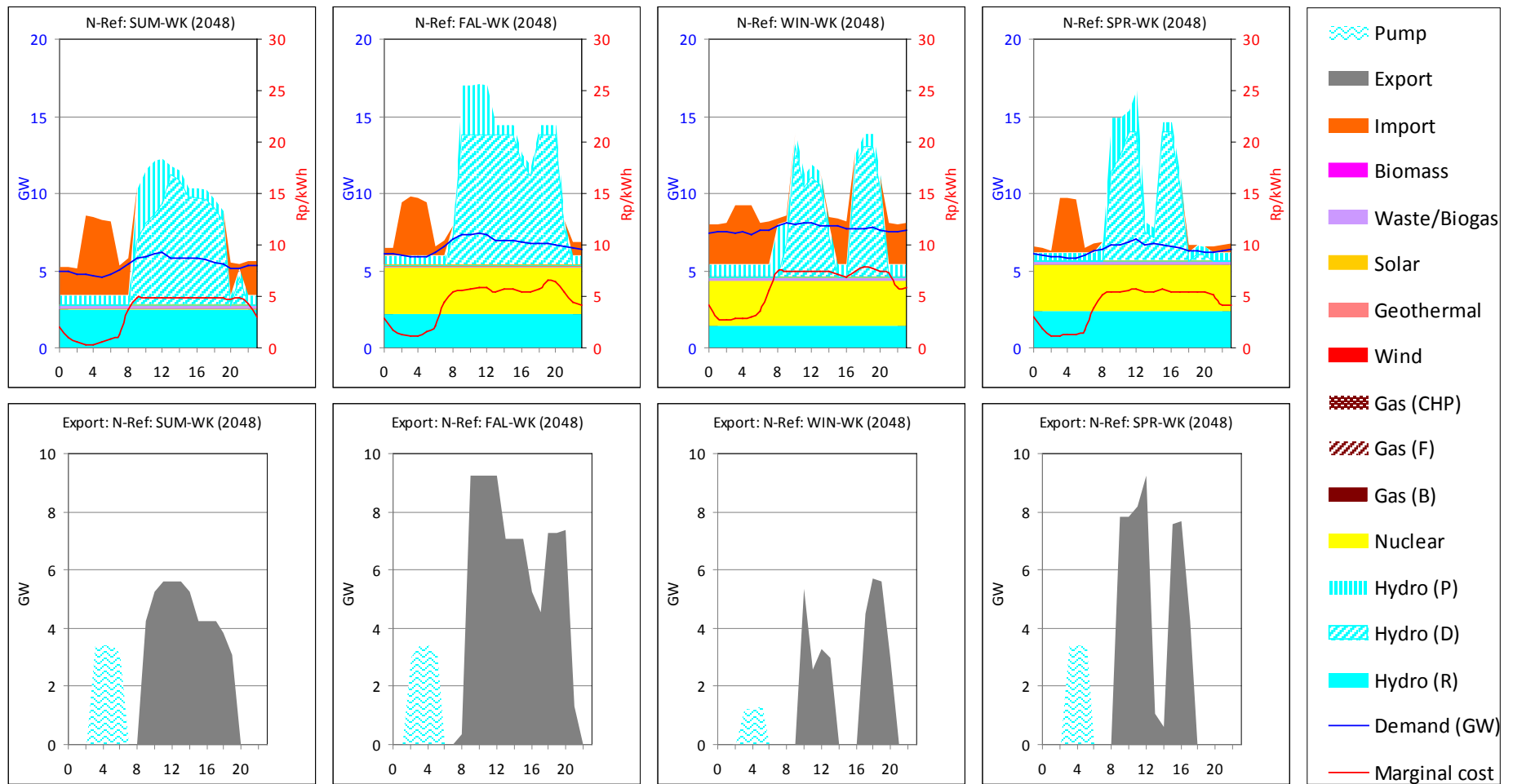


Fig. A-VI-42: Electricity generation schedule on weekdays – N-Ref

Appendix VII: WWB demand and gas based electricity supply (W-Gas)

Tab. A-VII-25: Electricity generation mix: W-Gas

Electricity generation mix (PJ): W-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)		1	12	29	63	86	77
Gas (CHP)	3	3	2	1			
Gas (Flex)	0		1	7	2	1	
Nuclear	91	95	82	63	14		
Hydro	135	130	142	145	150	150	147
Renewable	9	8	8	8	27	42	53
Pumps	-9	-3	-10	-12	-16	-15	-13
Total	229	234	237	240	240	262	265

Renewable electricity generation (PJ): W-Gas

Geothermal							
Solar	0	0	0	0	19	25	35
Wind	0	0	0	0	0	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	27	42	53
Net electricity import, if any	2		0		0		

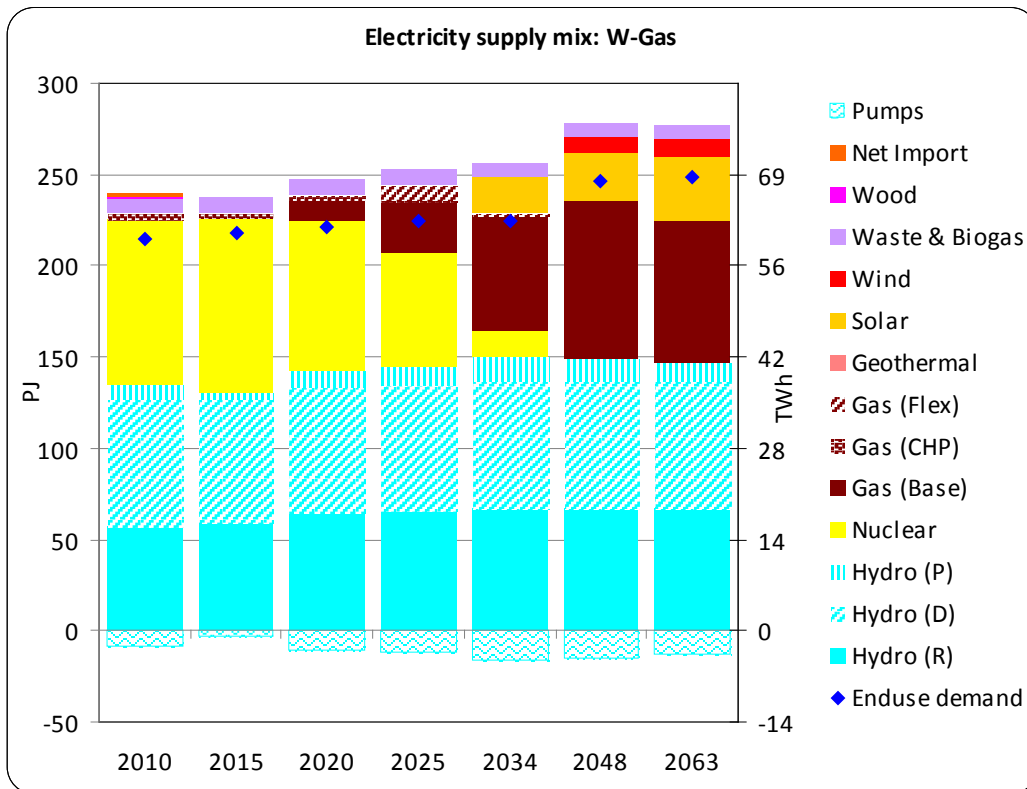


Fig. A-VII-43: Electricity generation mix – W-Gas

Tab. A-VII-26: Installed capacity – W-Gas

Installed Capacity (GW): W-Gas

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)		0.4	1.1	1.1	4.0	3.9	3.8
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.2	0.6	0.6	0.2	
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.4	13.8	13.6	14.0	14.3	14.3
Renewable	0.7	0.6	0.7	1.0	6.7	10.5	13.5
Total	17.3	17.8	18.8	18.5	25.7	28.9	31.5

Renewable Capacity (GW): W-Gas

Geothermal							
Solar	0.0	0.0	0.0	0.0	5.5	7.4	10.2
Wind	0.0	0.0	0.0	0.0	0.0	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	6.7	10.5	13.5

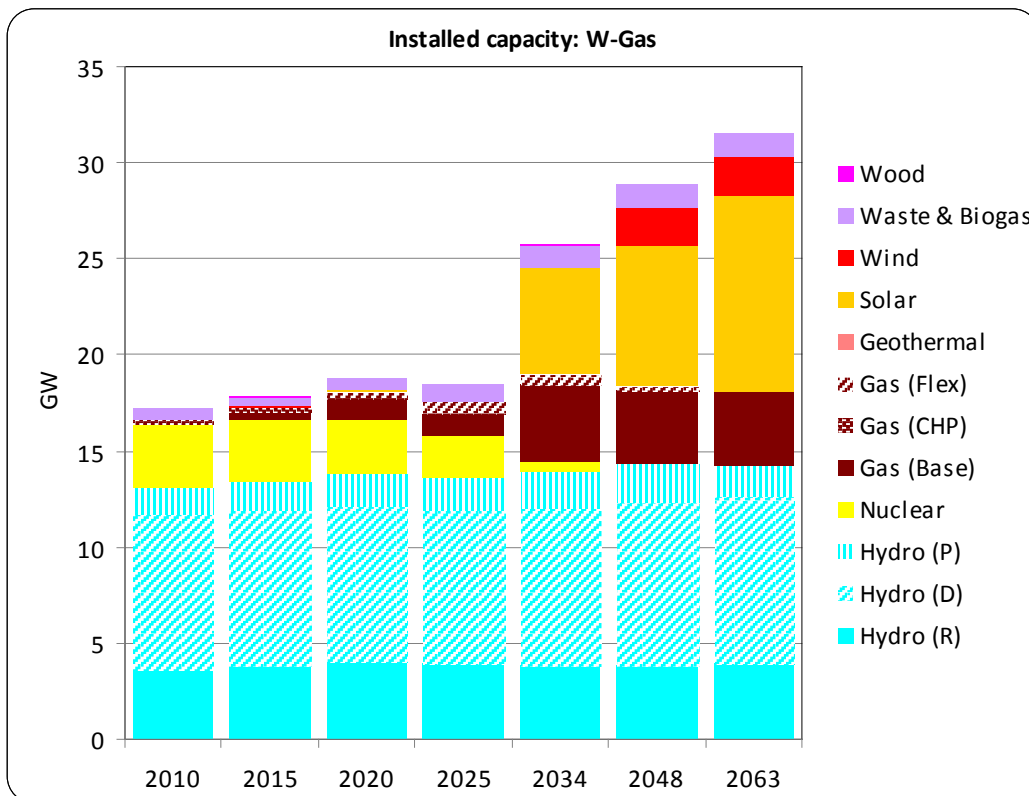


Fig. A-VII-44: Installed capacity – W-Gas

Tab. A-VII-27: Annual undiscounted system cost by category – W-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): W-Gas

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.6	1.1	1.6	2.5	2.2
Capital	1.5	1.5	1.7	1.7	2.6	3.0	3.5
Variable O&M	0.8	0.7	0.8	0.9	1.0	1.2	1.1
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.9	0.9	1.0	1.0
Trade Balance	-0.3	-0.5	-0.7	-0.9	-1.2	-1.2	-1.2
Heat credit	-0.3	-0.2	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.3	3.6	4.1	5.3	6.9	7.1

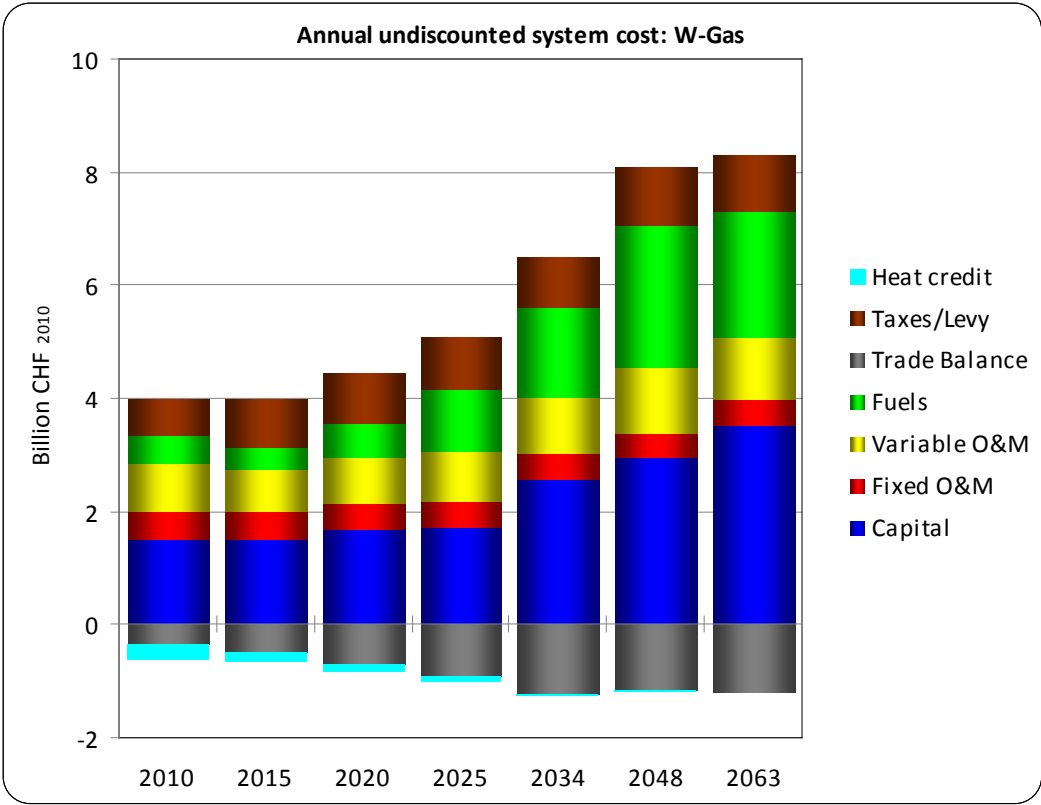


Fig. A-VII-45: Annual undiscounted system cost by cost category – W-Gas

Tab. A-VII-28: Annual undiscounted system cost by technology – W-Gas

Undiscounted system cost (Billion CHF₂₀₁₀): W-Gas

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.8
Gas	0.2	0.2	0.6	1.5	2.7	3.8	3.4
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	0.7	1.2	1.5
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	-0.1	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.7	0.7	0.7	0.7	0.9	0.9
Import/Export	-0.1	-0.4	-0.6	-0.7	-1.0	-0.8	-0.7
Total	3.4	3.3	3.6	4.1	5.3	6.9	7.1

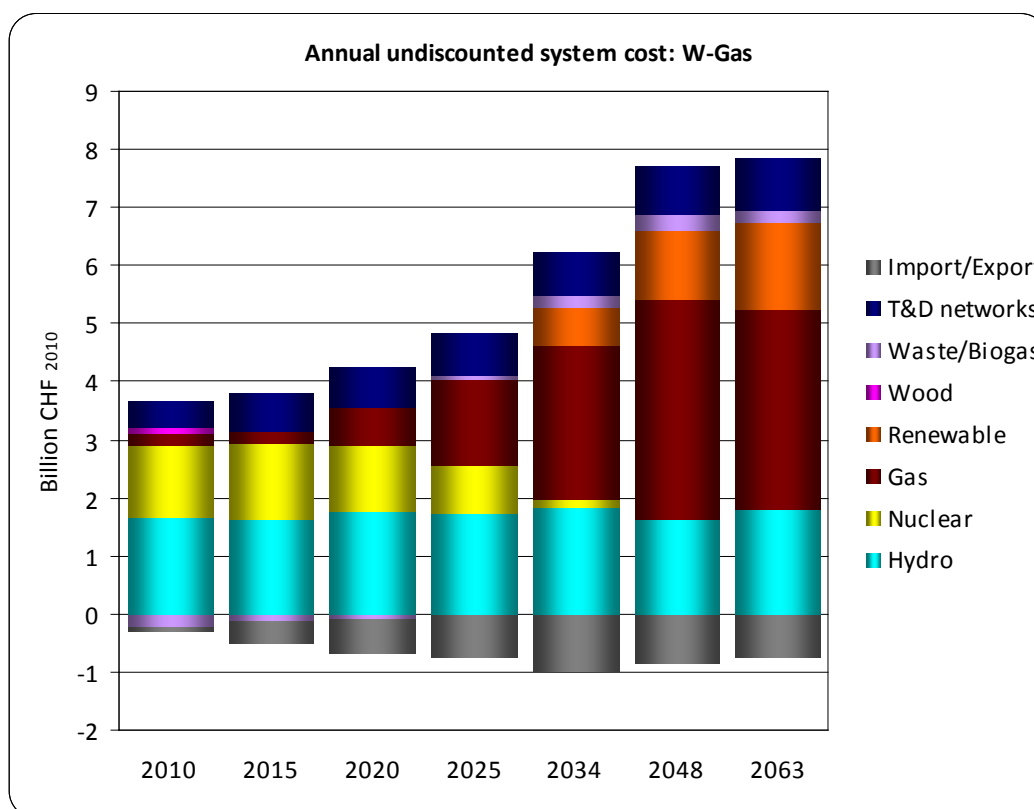


Fig. A-VII-46: Annual undiscounted system cost by technology category – W-Gas

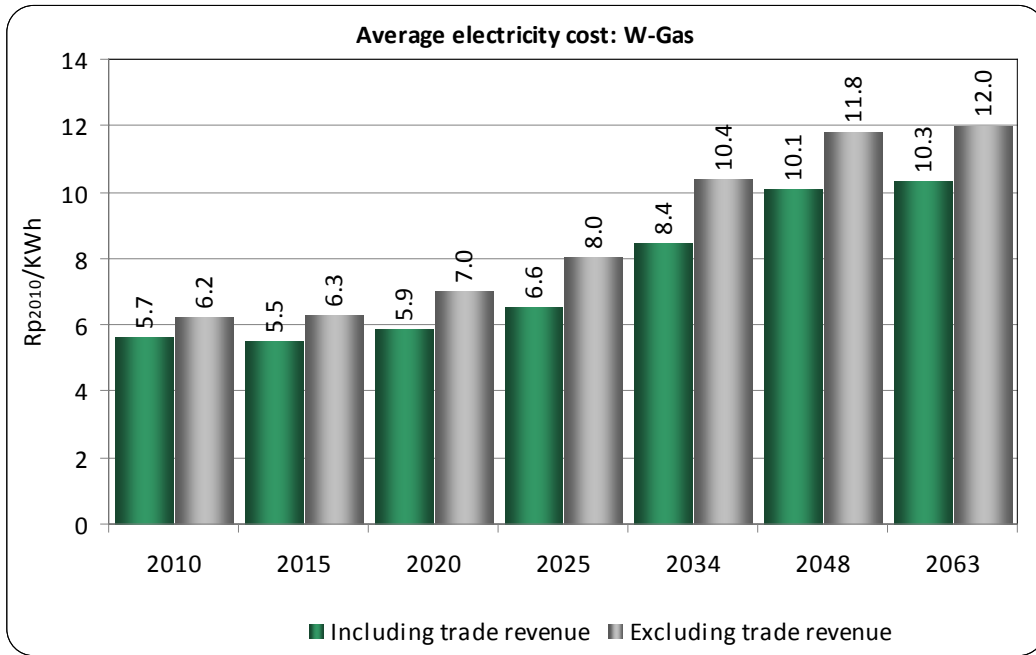


Fig. A-VII-47: Average cost of electricity – W-Gas

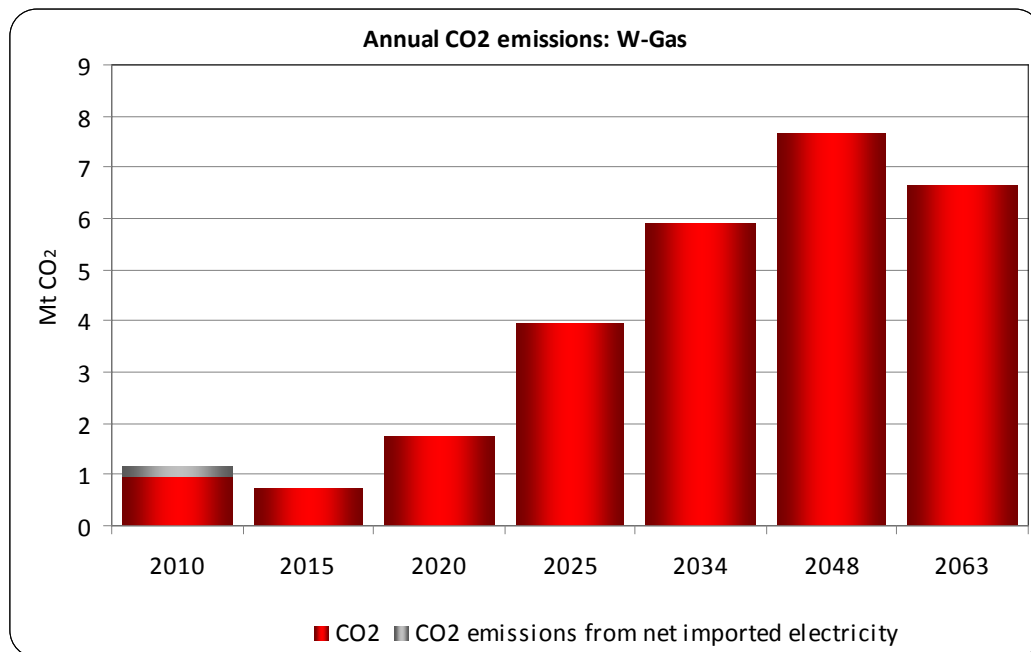


Fig. A-VII-48: Annual CO₂ emissions – W-Gas

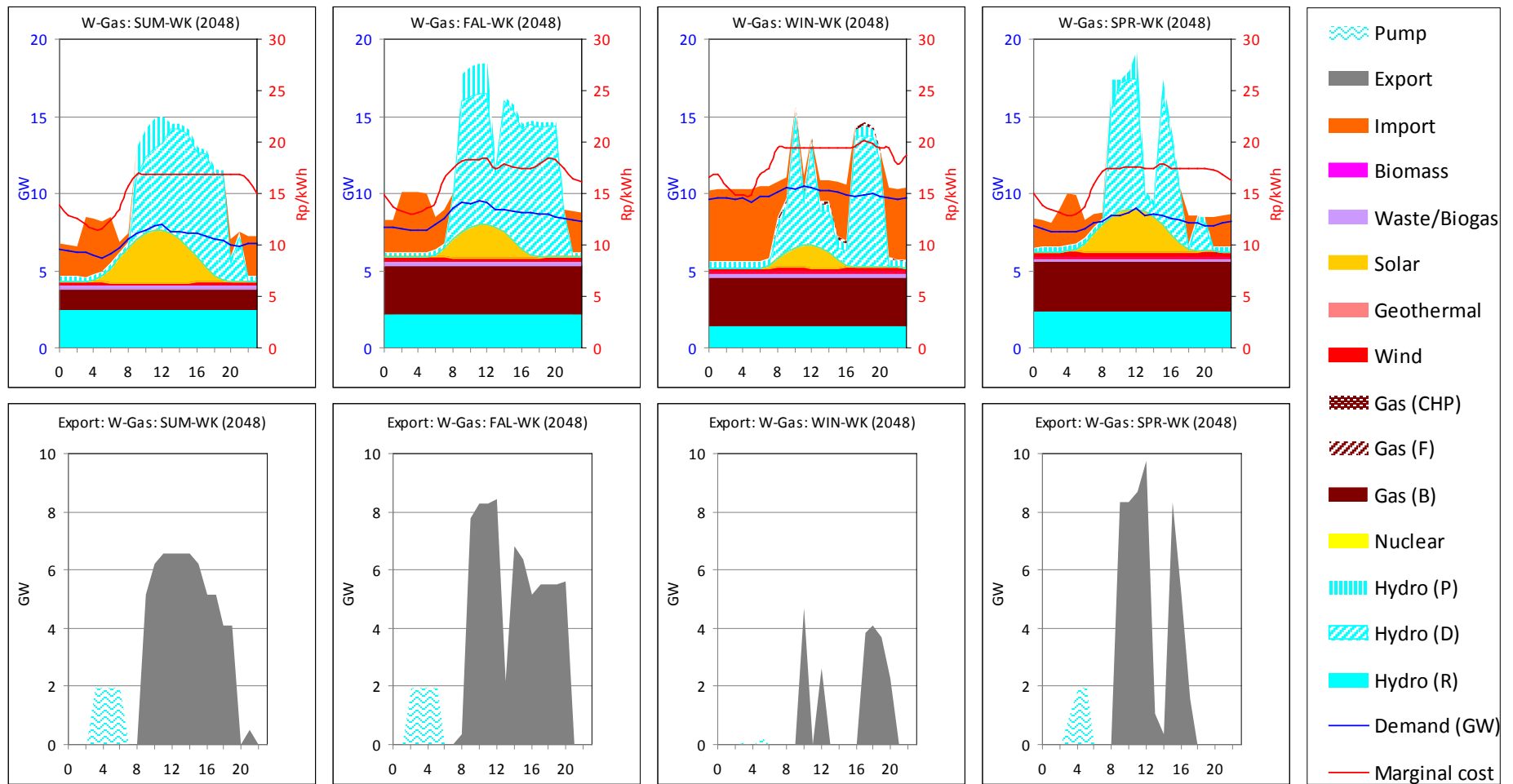


Fig. A-VII-49: Electricity generation schedule on weekdays – W-Gas

Appendix VIII: WWB demand and import/renewable electricity supply (W-Imp)

Tab. A-VIII-29: Electricity generation mix: W-Imp

Electricity generation mix (PJ): W-Imp

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	3	3	2	1	0		
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	128	138	135	139	139	139
Renewable	9	8	8	13	35	73	75
Pumps	-9		-6		-3	-2	-3
Total	229	234	225	212	186	210	212

Renewable electricity generation (PJ): W-Imp

Geothermal			0	2	4	14	16
Solar	0	0	0	0	19	33	35
Wind	0	0	0	2	4	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1			0		9	7
Total renewable	9	8	8	13	35	73	75
Net electricity import, if any	2		11	27	51	49	49

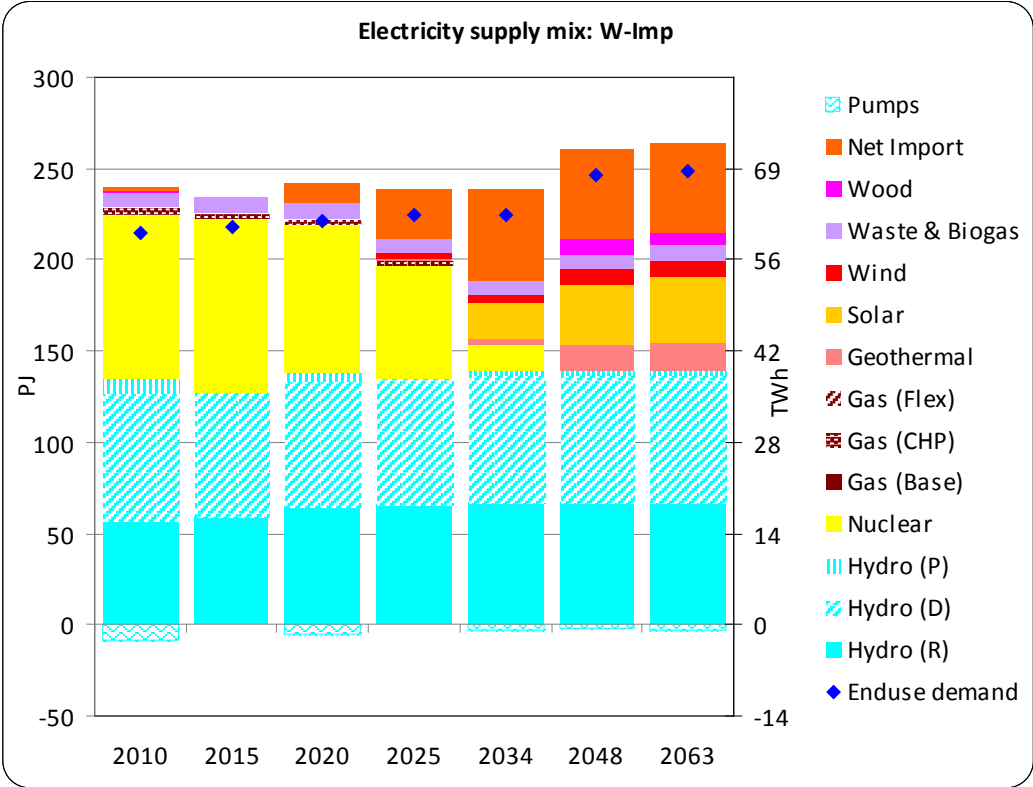


Fig. A-VIII-50: Electricity generation mix – W-Imp

Tab. A-VIII-30: Installed capacity – *W-Imp*

Installed Capacity (GW): *W-Imp*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)							
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.3	13.6	13.4	13.5	13.8	13.8
Renewable	0.7	0.6	0.8	1.6	7.8	13.9	14.5
Total	17.3	17.3	17.3	17.2	21.8	27.7	28.3

Renewable Capacity (GW): *W-Imp*

Geothermal			0	0	0	1	1
Solar	0.0	0.0	0.0	0.0	5.5	9.6	10.2
Wind	0.0	0.1	0.0	0.6	0.9	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0	0.6	0.4
Total renewable	0.7	0.6	0.8	1.6	7.8	13.9	14.5

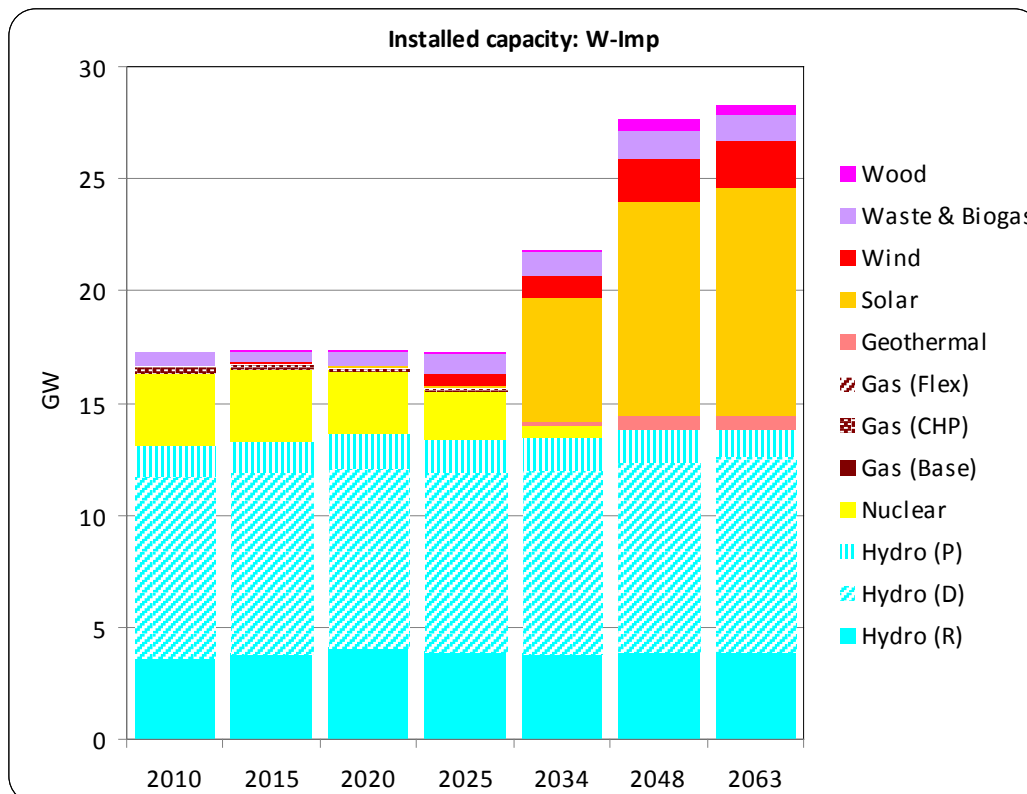


Fig. A-VIII-51: Installed capacity – *W-Imp*

Tab. A-VIII-31: Annual undiscounted system cost by category – W-Imp

Undiscounted system cost (Billion CHF₂₀₁₀): W-Imp

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.3	0.3	0.0	0.3	0.3
Capital	1.5	1.5	1.6	1.7	2.4	3.5	3.8
Variable O&M	0.8	0.7	0.7	0.7	0.6	0.8	0.8
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.7	0.6	0.6	0.6
Trade Balance	-0.3	-0.5	-0.3	0.4	1.7	1.6	1.5
Heat credit	-0.3	-0.2	-0.1	-0.1	0.0	-0.1	-0.1
Total cost	3.4	3.3	3.5	4.2	5.8	7.3	7.5

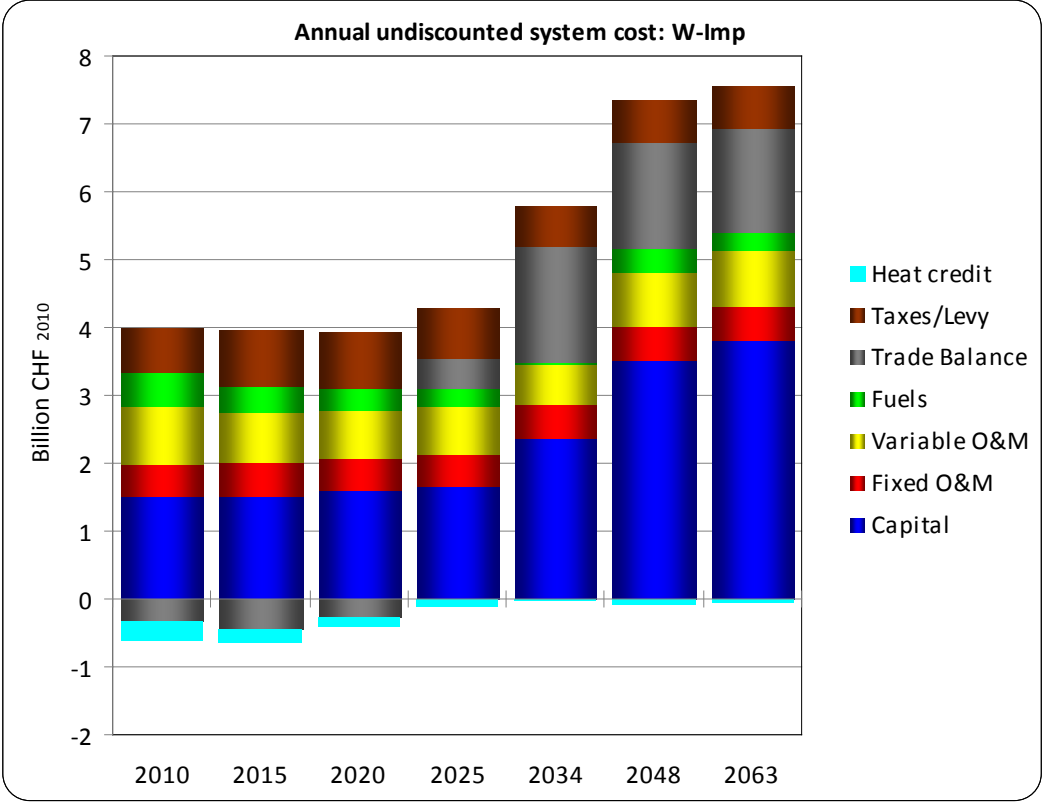


Fig. A-VIII-52: Annual undiscounted system cost by cost category – W-Imp

Tab. A-VIII-32: Annual undiscounted system cost by technology – *W-Imp*

Undiscounted system cost (Billion CHF₂₀₁₀): *W-Imp*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.6	1.8
Gas	0.2	0.2	0.1	0.1	0.0		
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable		0.0	0.0	0.2	1.0	2.2	2.3
Wood	0.1	0.0	0.0	0.0	0.0	0.6	0.5
Waste/Biogas	-0.2	-0.1	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.7	0.7	0.7	0.7	0.9	0.9
Import/Export	-0.1	-0.3	-0.1	0.6	1.8	1.8	1.9
Total	3.4	3.3	3.5	4.2	5.8	7.3	7.5

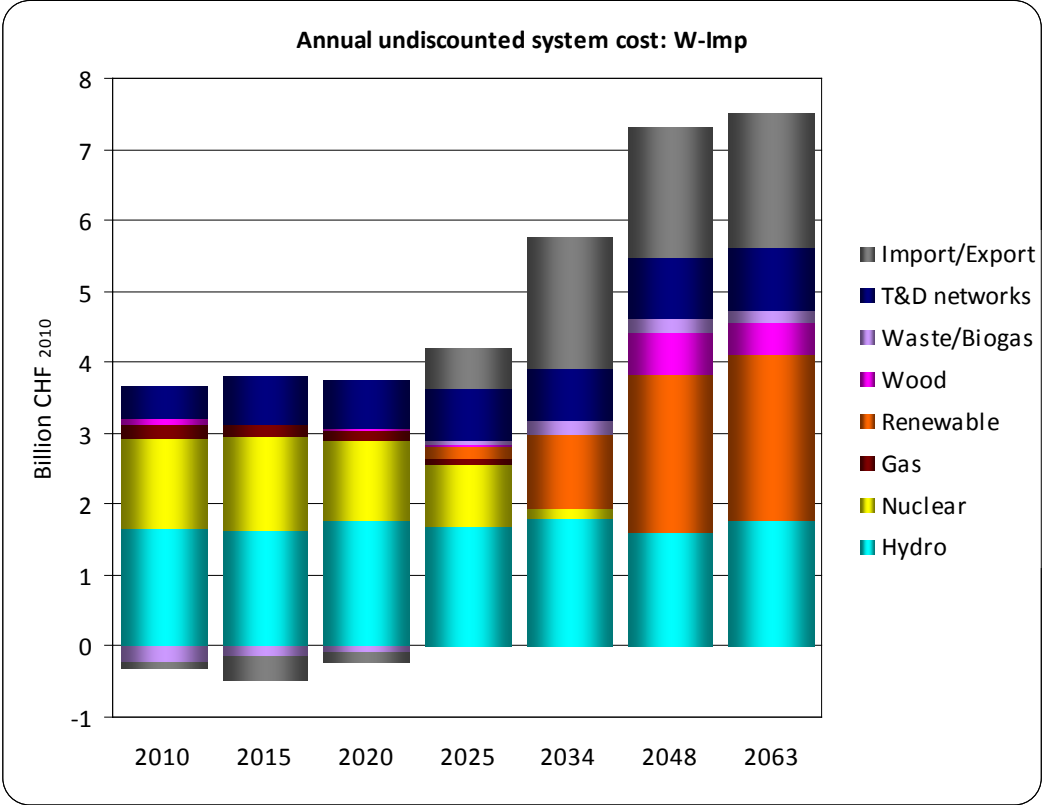


Fig. A-VIII-53: Annual undiscounted system cost by technology category – *W-Imp*

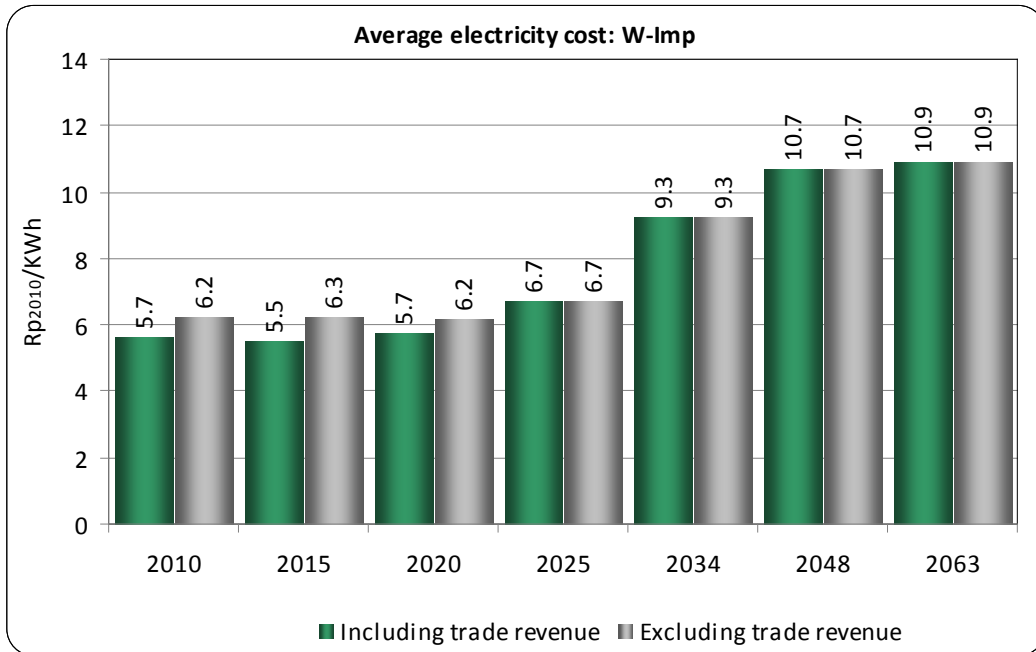


Fig. A-VIII-54: Average cost of electricity – W-Imp

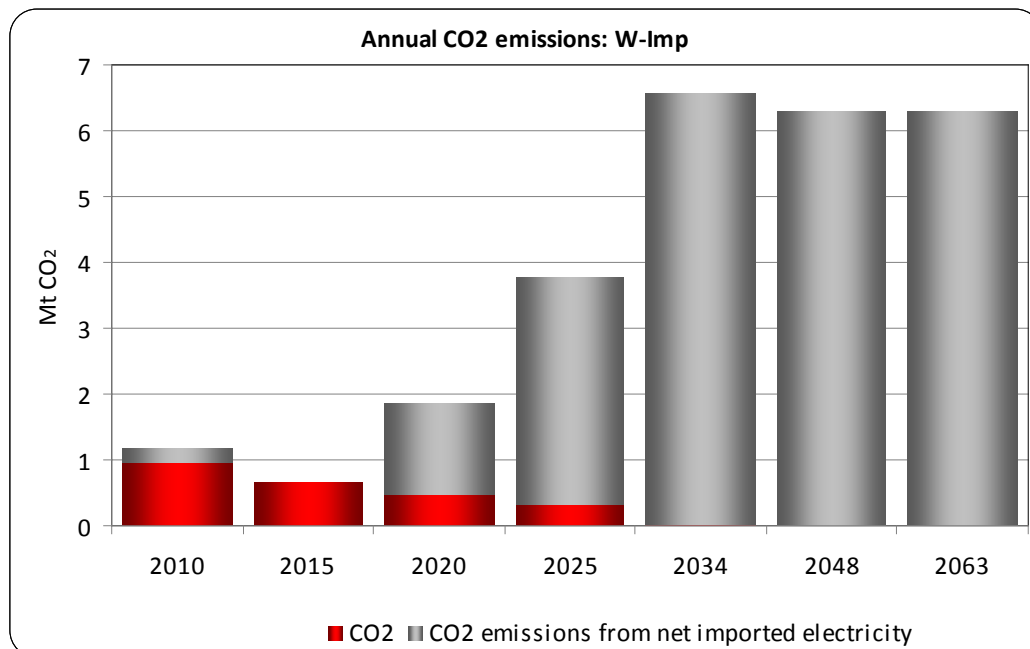


Fig. A-VIII-55: Annual CO₂ emissions – W-Imp

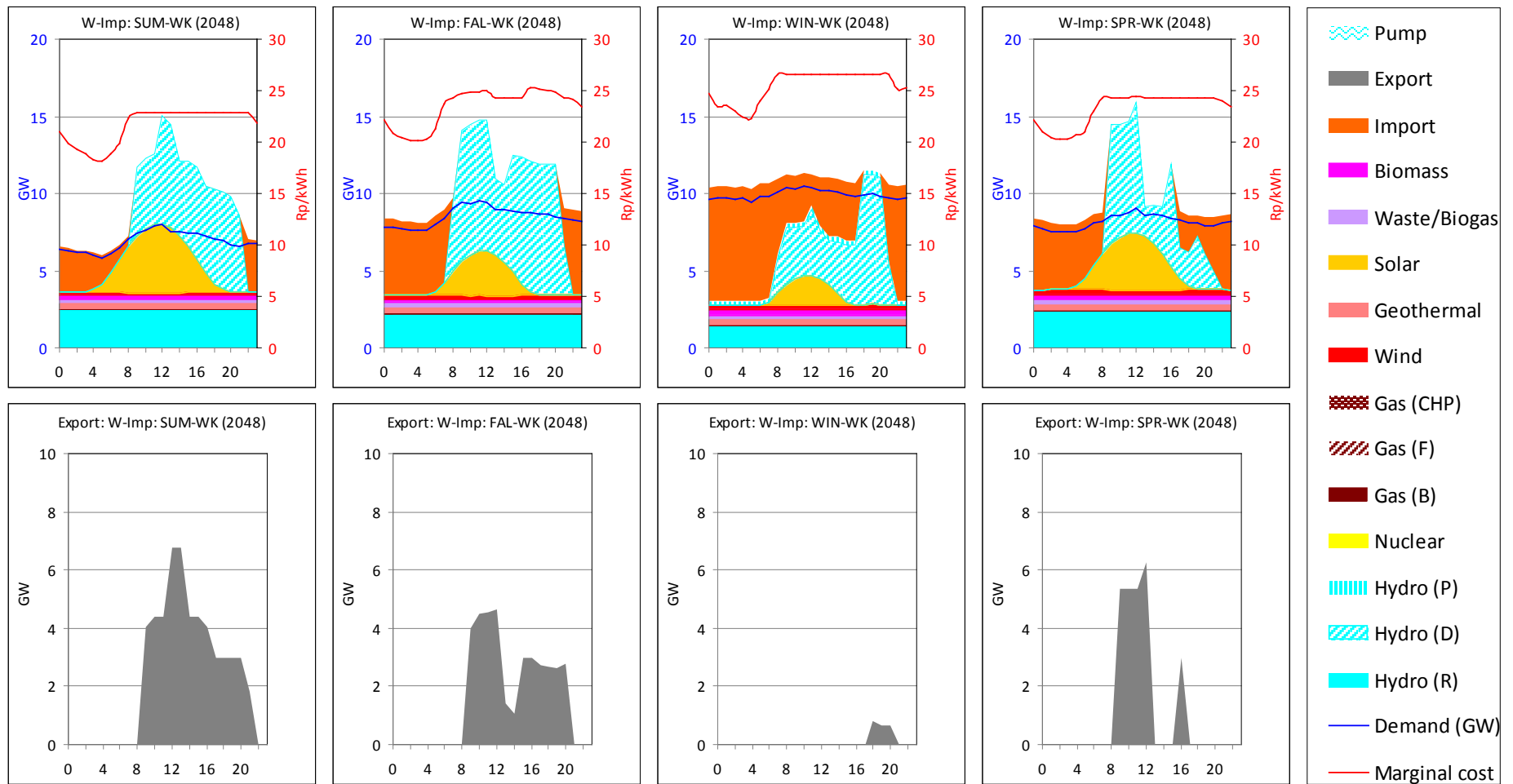


Fig. A-VIII-56: Electricity generation schedule on weekdays – *W-Imp*

Appendix IX: WWB demand and nuclear electricity supply (W-Ref)

Tab. A-IX-33: Electricity generation mix: W-Ref

Electricity generation mix (PJ): W-Ref

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			8	29		19	
Gas (CHP)	3	3	6	6			
Gas (Flex)	0						
Nuclear	91	95	82	63	90	91	116
Hydro	135	129	138	136	156	154	160
Renewable	9	8	8	8	18	19	17
Pumps	-9	-1	-6	-1	-24	-21	-29
Total	229	234	237	240	240	262	265

Renewable electricity generation (PJ): W-Ref

Geothermal							
Solar	0	0	0	0	10	10	9
Wind	0	0	0	0	0	1	0
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	18	19	17
Net electricity import, if any	2						

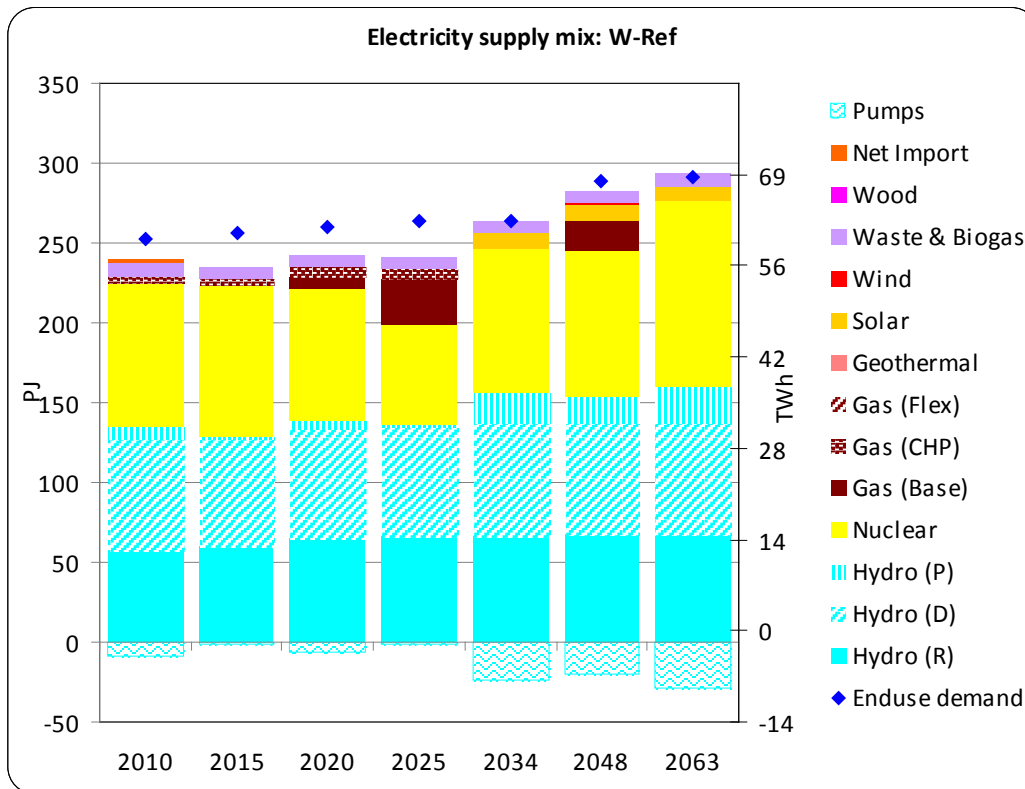


Fig. A-IX-57: Electricity generation mix – W-Ref

Tab. A-IX-34: Installed capacity – W-Ref

Installed Capacity (GW): W-Ref

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.4	1.1	1.1	0.8	0.5
Gas (CHP)	0.2	0.2	0.4	0.4	0.3		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	3.5	3.6	4.6
Hydro	13.1	13.3	13.6	13.4	14.8	15.1	16.2
Renewable	0.7	0.6	0.7	1.0	4.1	4.4	3.8
Total	17.3	17.4	18.0	18.0	23.7	23.9	25.1

Renewable Capacity (GW): W-Ref

Geothermal							
Solar	0.0	0.0	0.0	0.0	2.9	2.9	2.5
Wind	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	4.1	4.4	3.8

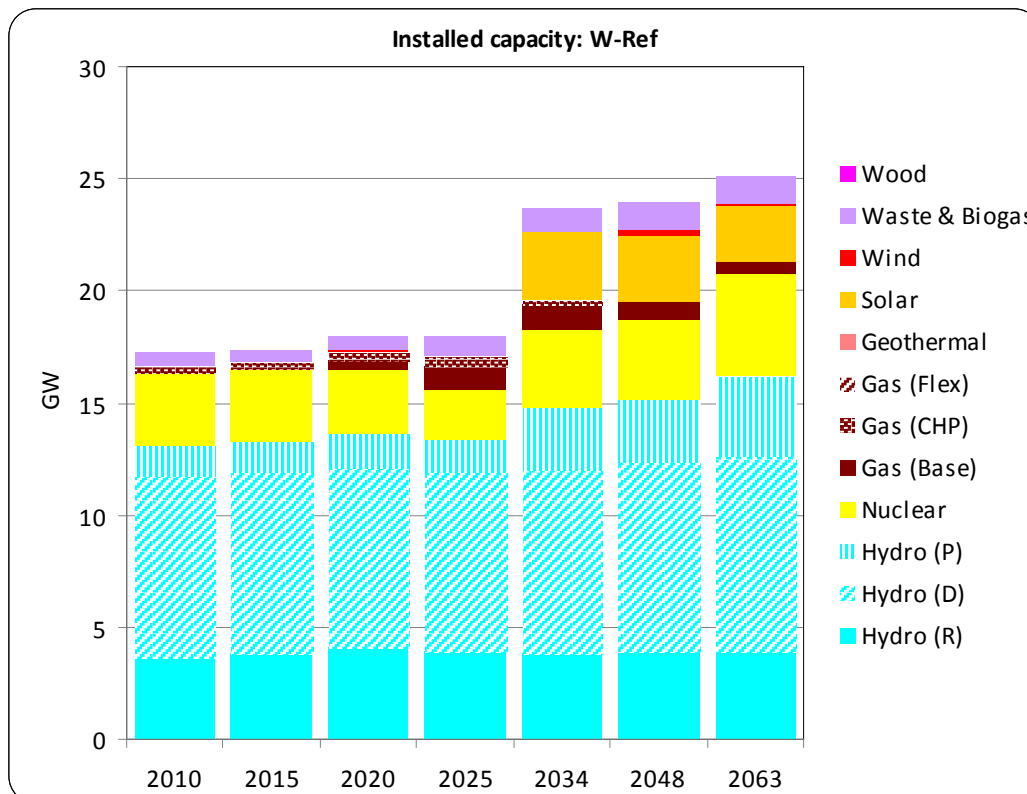


Fig. A-IX-58: Installed capacity – W-Ref

Tab. A-IX-35: Annual undiscounted system cost by category – W-Ref

Undiscounted system cost (Billion CHF₂₀₁₀): W-Ref

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.7	1.1	0.2	0.8	0.3
Capital	1.5	1.5	1.7	1.7	2.5	2.7	3.1
Variable O&M	0.8	0.7	0.8	0.9	0.7	0.8	0.7
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.9	0.9	0.8	1.0	0.9
Trade Balance	-0.3	-0.5	-0.6	-0.7	-1.3	-1.2	-1.4
Heat credit	-0.3	-0.2	-0.2	-0.2	0.0	0.0	0.0
Total cost	3.4	3.3	3.6	4.1	3.5	4.4	4.1

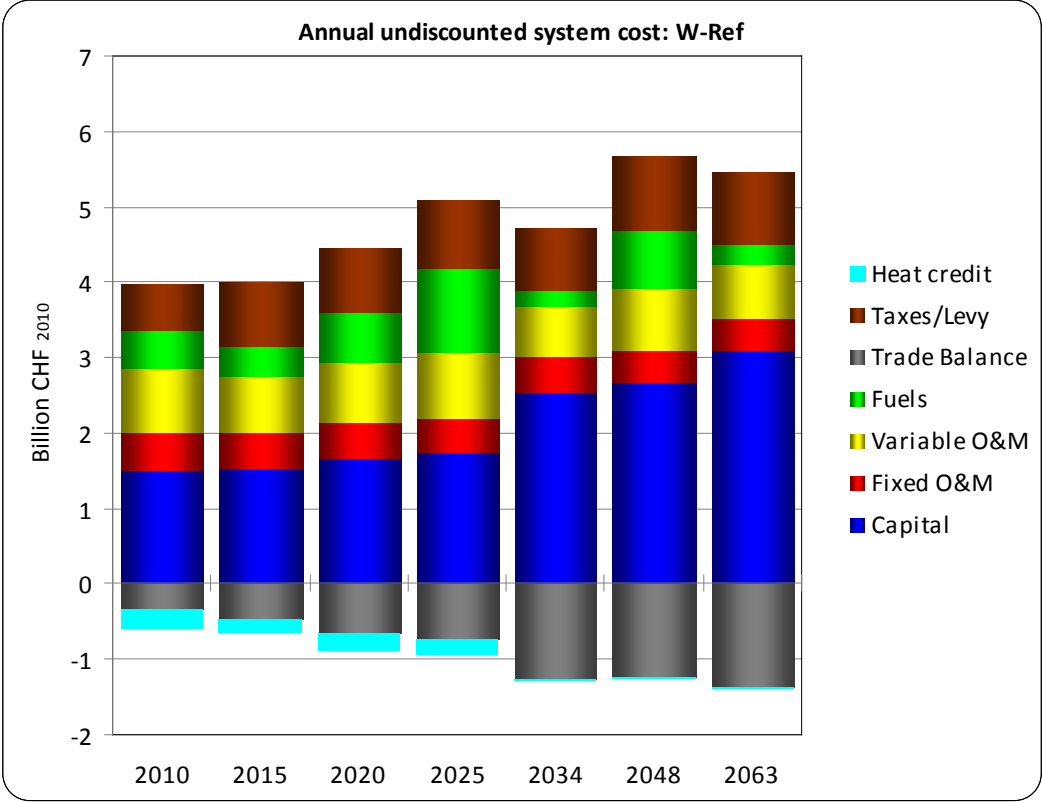


Fig. A-IX-59: Annual undiscounted system cost by cost category – W-Ref

Tab. A-IX-36: Annual undiscounted system cost by technology – *W-Ref*

Undiscounted system cost (Billion CHF₂₀₁₀): *W-Ref*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.9
Gas	0.2	0.2	0.7	1.5	0.1	0.8	0.0
Nuclear	1.3	1.3	1.1	0.9	1.1	1.3	1.6
Renewable				0.0	0.3	0.4	0.3
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	-0.1	-0.2	0.0	0.2	0.2	0.2
T&D networks	0.5	0.7	0.7	0.7	0.7	0.9	0.9
Import/Export	-0.1	-0.3	-0.5	-0.6	-1.0	-0.9	-0.9
Total	3.4	3.3	3.6	4.1	3.5	4.4	4.1

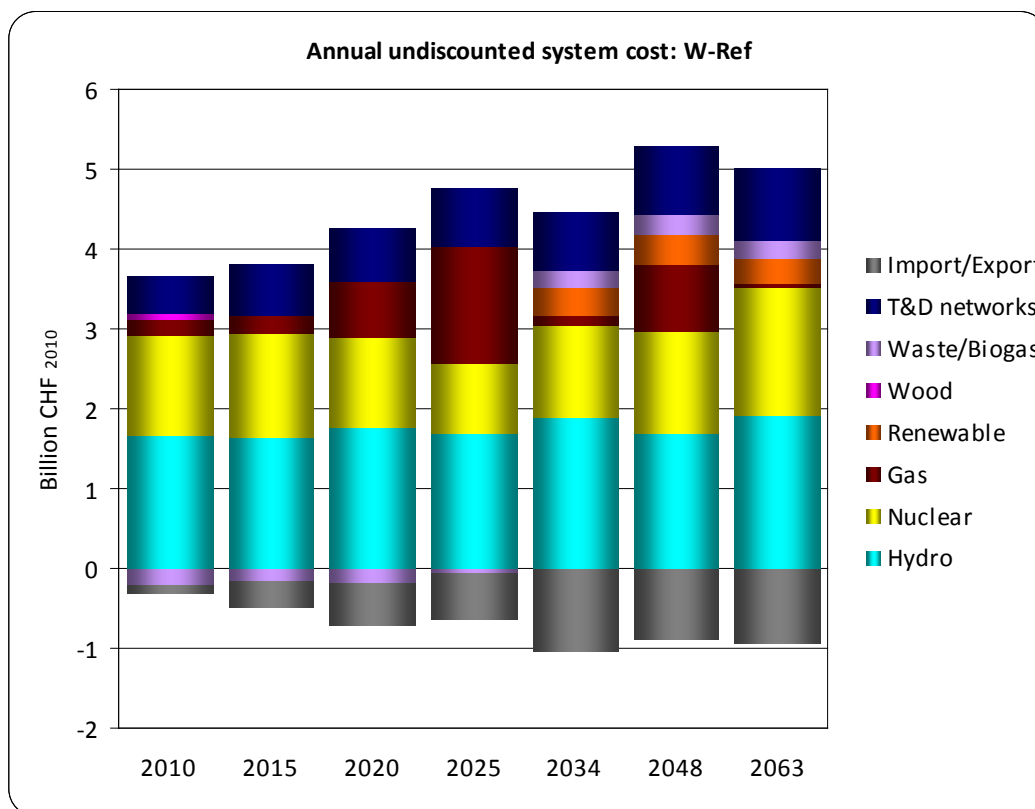


Fig. A-IX-60: Annual undiscounted system cost by technology category – *W-Ref*

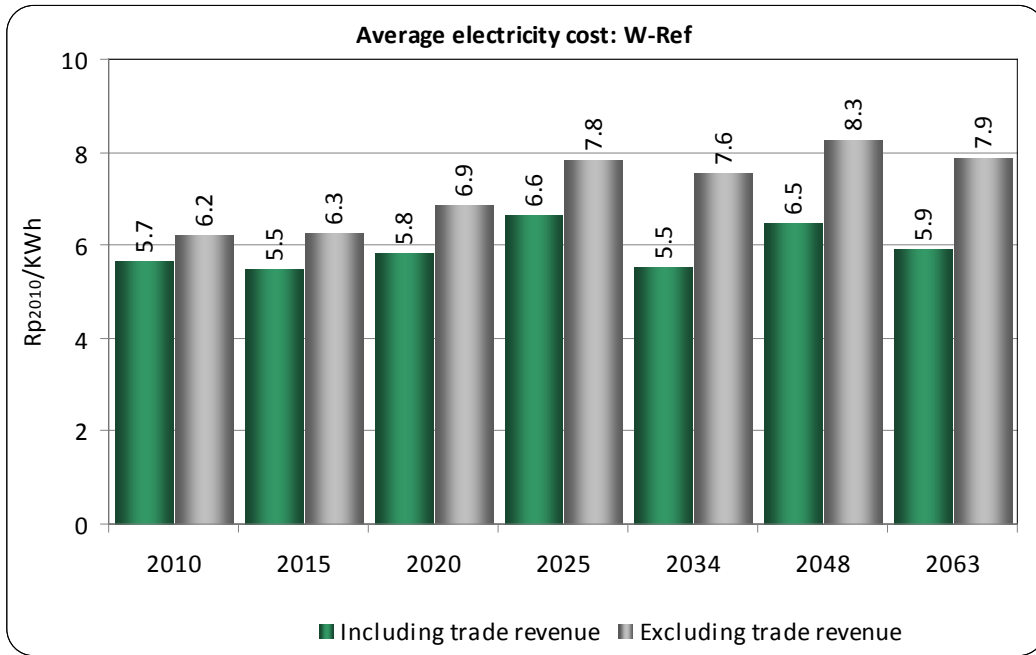


Fig. A-IX-61: Average cost of electricity – W-Ref

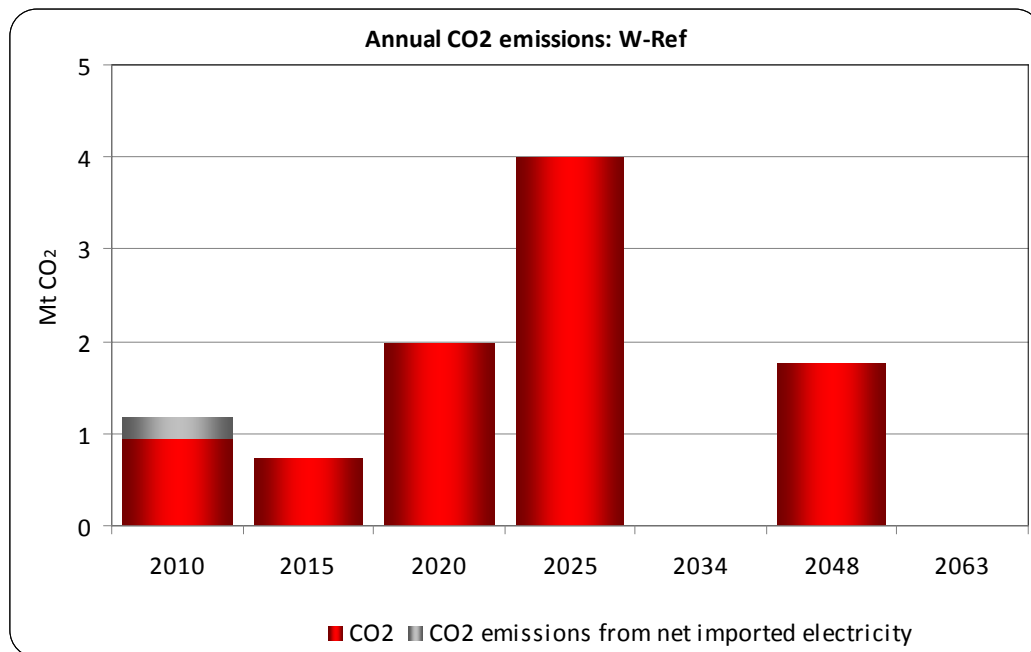


Fig. A-IX-62: Annual CO₂ emissions – W-Ref

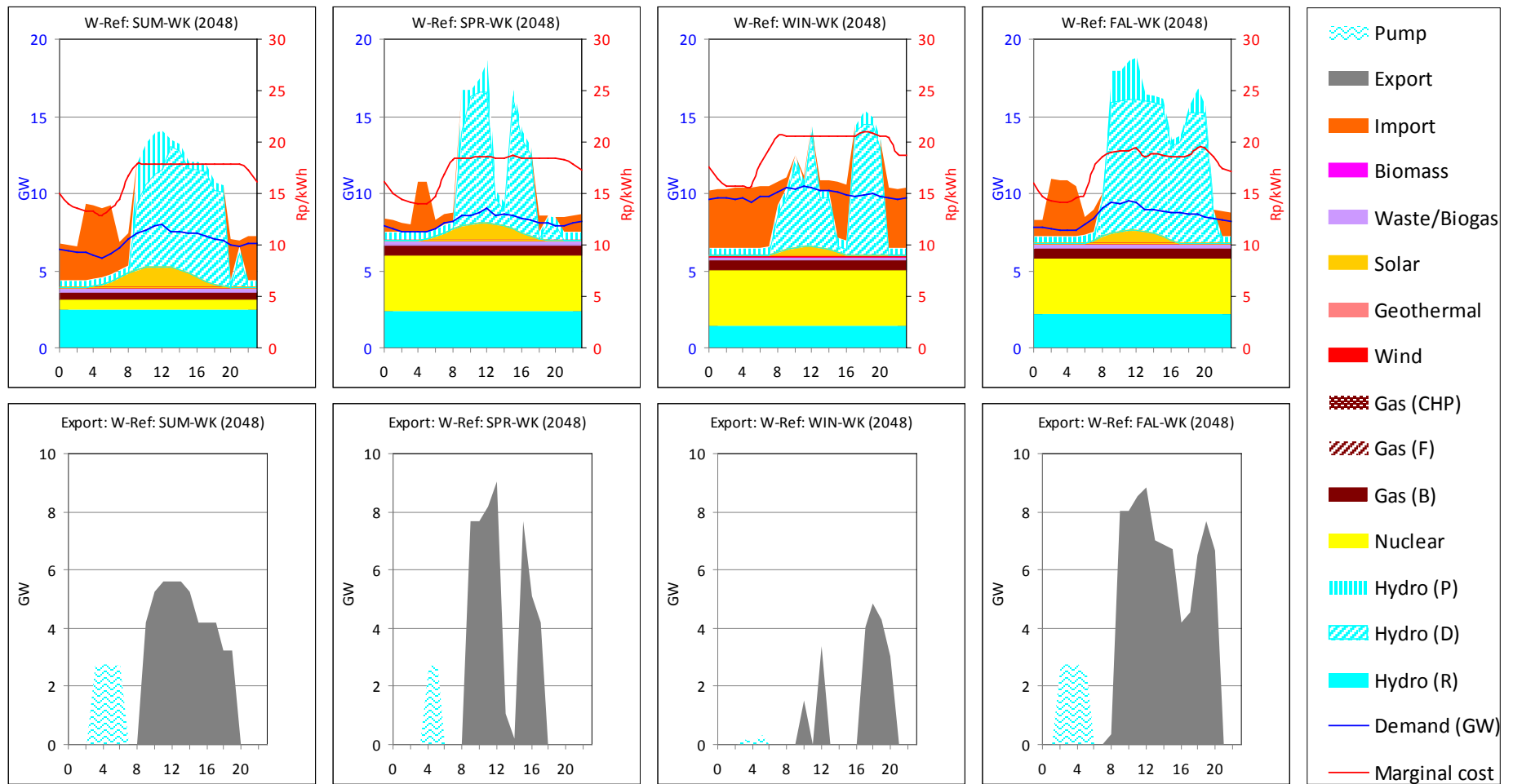


Fig. A-IX-63: Electricity generation schedule on weekdays – *W-Ref*

Appendix X: POM demand and gas based electricity supply with winter security (*P-Gas-S-win*)

Tab. A-X-37: Electricity generation mix: *P-Gas-S-win*

Electricity generation mix (PJ): *P-Gas-S-Win*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			3	19	45	61	46
Gas (CHP)	3		2	1	0		
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	135	145	146	148	148	146
Renewable	9	8	8	8	27	36	53
Pumps	-9	-9	-14	-14	-14	-13	-11
Total	229	229	226	224	220	232	233

Renewable electricity generation (PJ): *P-Gas-S-Win*

Geothermal							
Solar	0	0	0	0	19	19	35
Wind	0	0	0	0	0	9	9
Waste & Biogas	8	7	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	27	36	53
Net electricity import, if any	2				0		

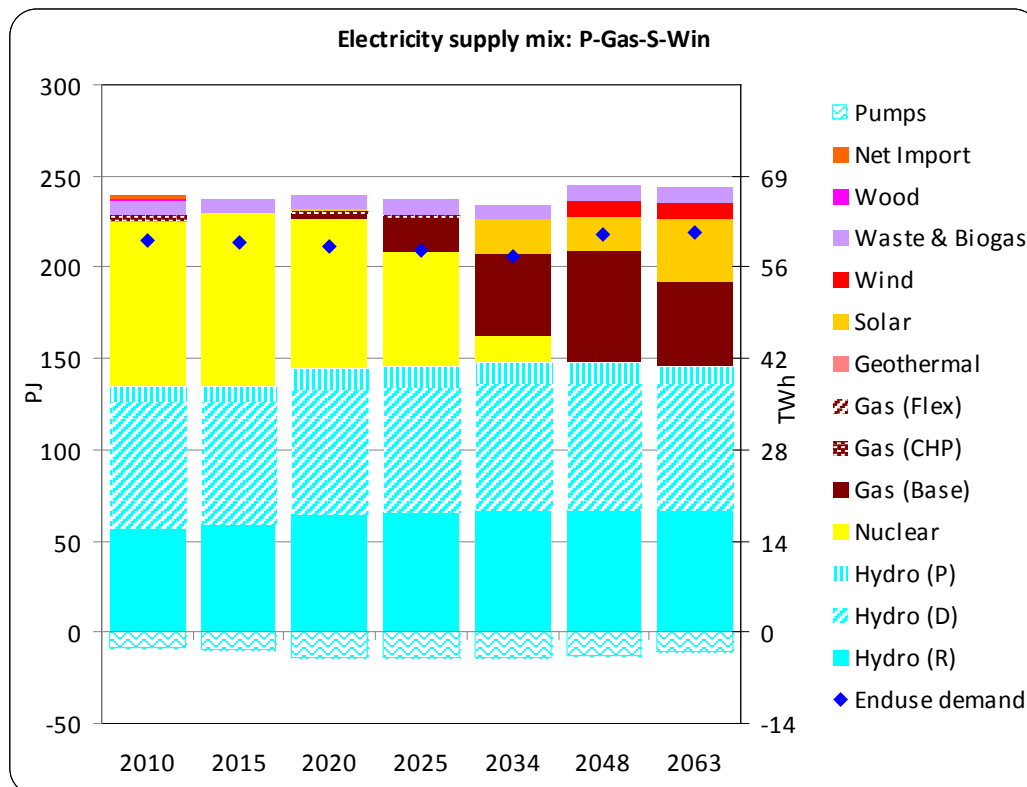


Fig. A-X-64: Electricity generation mix – *P-Gas-S-win*

Tab. A-X-38: Installed capacity – P-Gas-S-win

Installed Capacity (GW): P-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.4	1.1	3.2	5.3	4.8
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.4	13.9	13.7	13.8	14.1	14.1
Renewable	0.7	0.5	0.7	1.0	6.7	8.7	13.5
Total	17.3	17.4	18.0	18.0	24.2	28.1	32.4

Renewable Capacity (GW): P-Gas-S-Win

Geothermal							
Solar	0.0	0.0	0.0	0.0	5.5	5.5	10.2
Wind	0.0	0.0	0.0	0.0	0.0	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total renewable	0.7	0.5	0.7	1.0	6.7	8.7	13.5

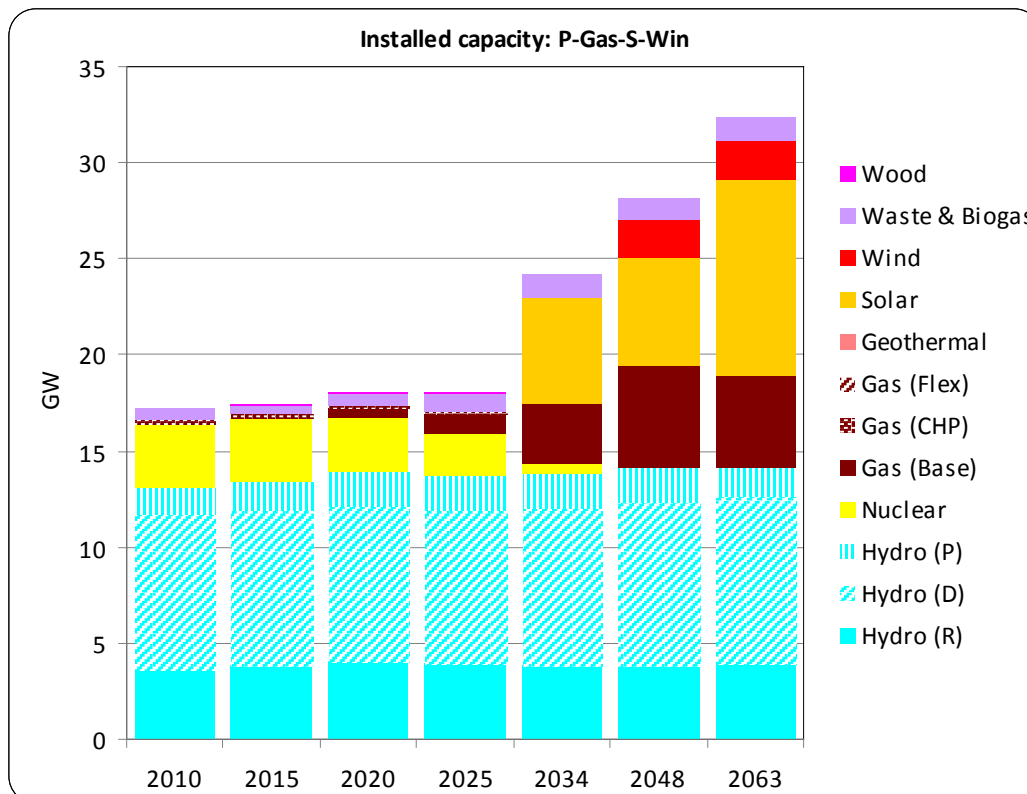


Fig. A-X-65: Installed capacity – P-Gas-S-win

Tab. A-X-39: Annual undiscounted system cost by category – P-Gas-S-win

Undiscounted system cost (Billion CHF₂₀₁₀): P-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.3	0.4	0.7	1.1	1.8	1.3
Capital	1.5	1.5	1.6	1.7	2.5	2.8	3.5
Variable O&M	0.8	0.7	0.7	0.8	0.8	1.0	0.9
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Trade Balance	-0.3	-0.5	-0.7	-0.9	-1.1	-1.0	-1.0
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.1	3.4	4.5	5.8	5.9

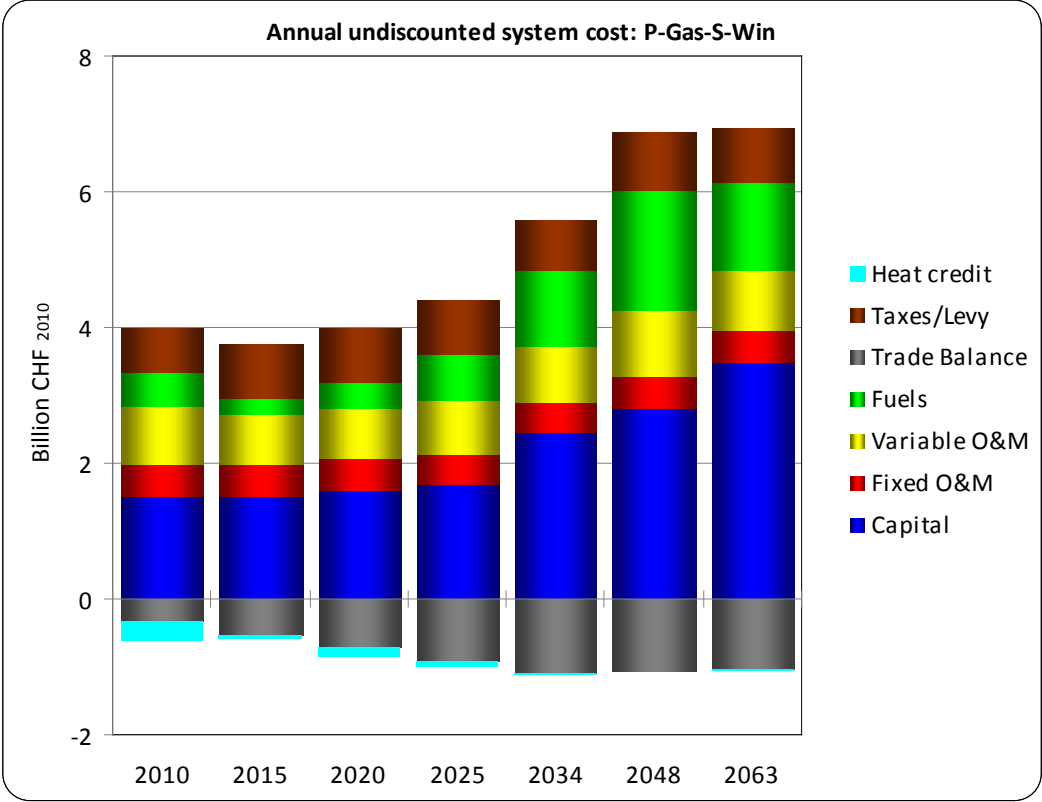


Fig. A-X-66: Annual undiscounted system cost by cost category – P-Gas-S-win

Tab. A-X-40: Annual undiscounted system cost by technology – *P-Gas-S-win*

Undiscounted system cost (Billion CHF₂₀₁₀): *P-Gas-S-Win*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.7	1.8
Gas	0.2	0.0	0.2	0.8	1.8	2.9	2.2
Nuclear	1.3	1.3	1.1	0.9	0.1	1.0	1.5
Renewable				0.0	0.7	1.0	1.5
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.4	-0.6	-0.7	-0.9	-0.7	-0.6
Total	3.4	3.2	3.1	3.4	4.5	5.8	5.9

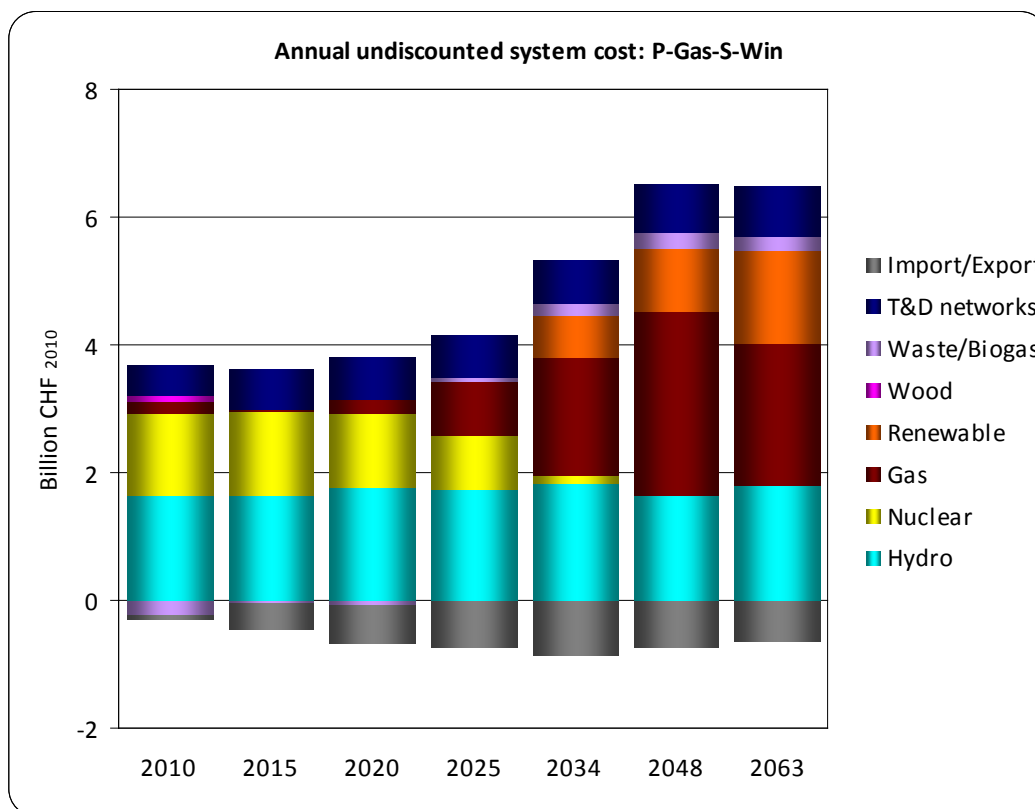


Fig. A-X-67: Annual undiscounted system cost by technology category – *P-Gas-S-win*

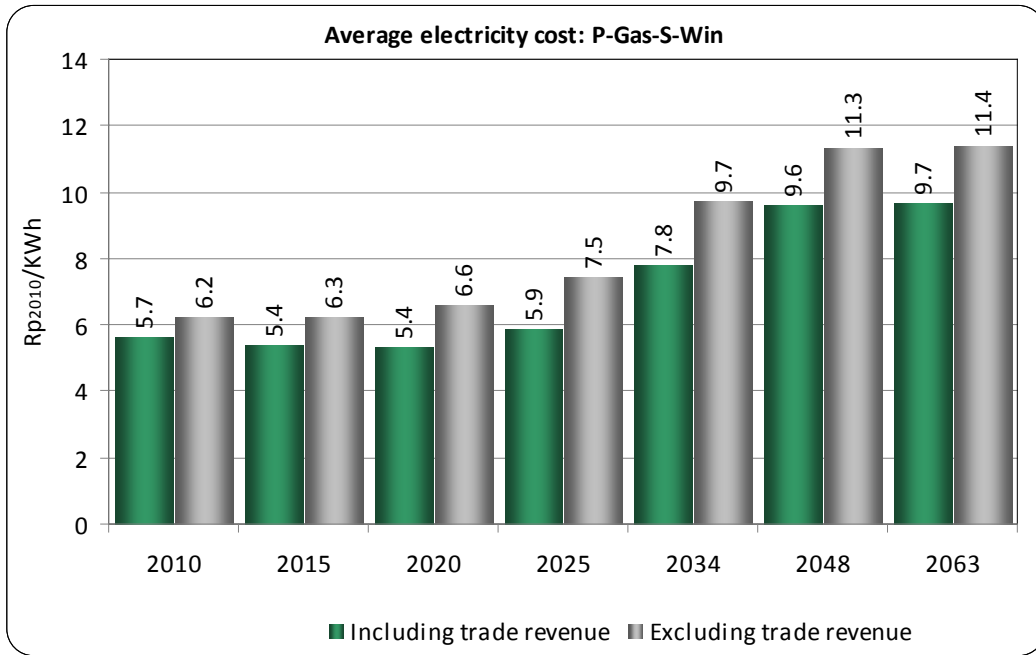


Fig. A-X-68: Average cost of electricity – P-Gas-S-win

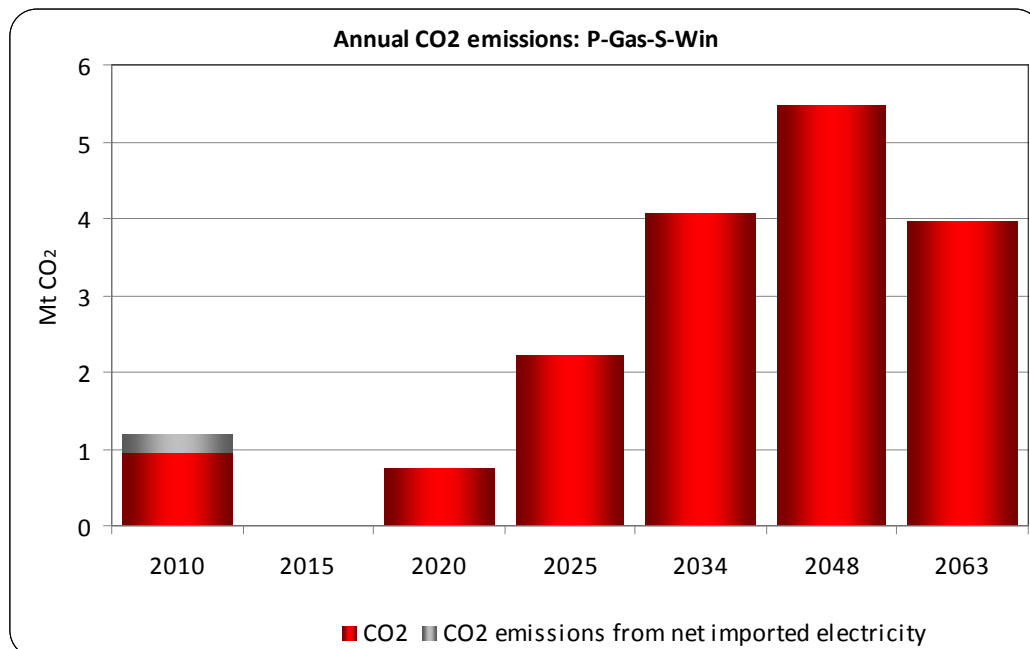


Fig. A-X-69: Annual CO₂ emissions – P-Gas-S-win

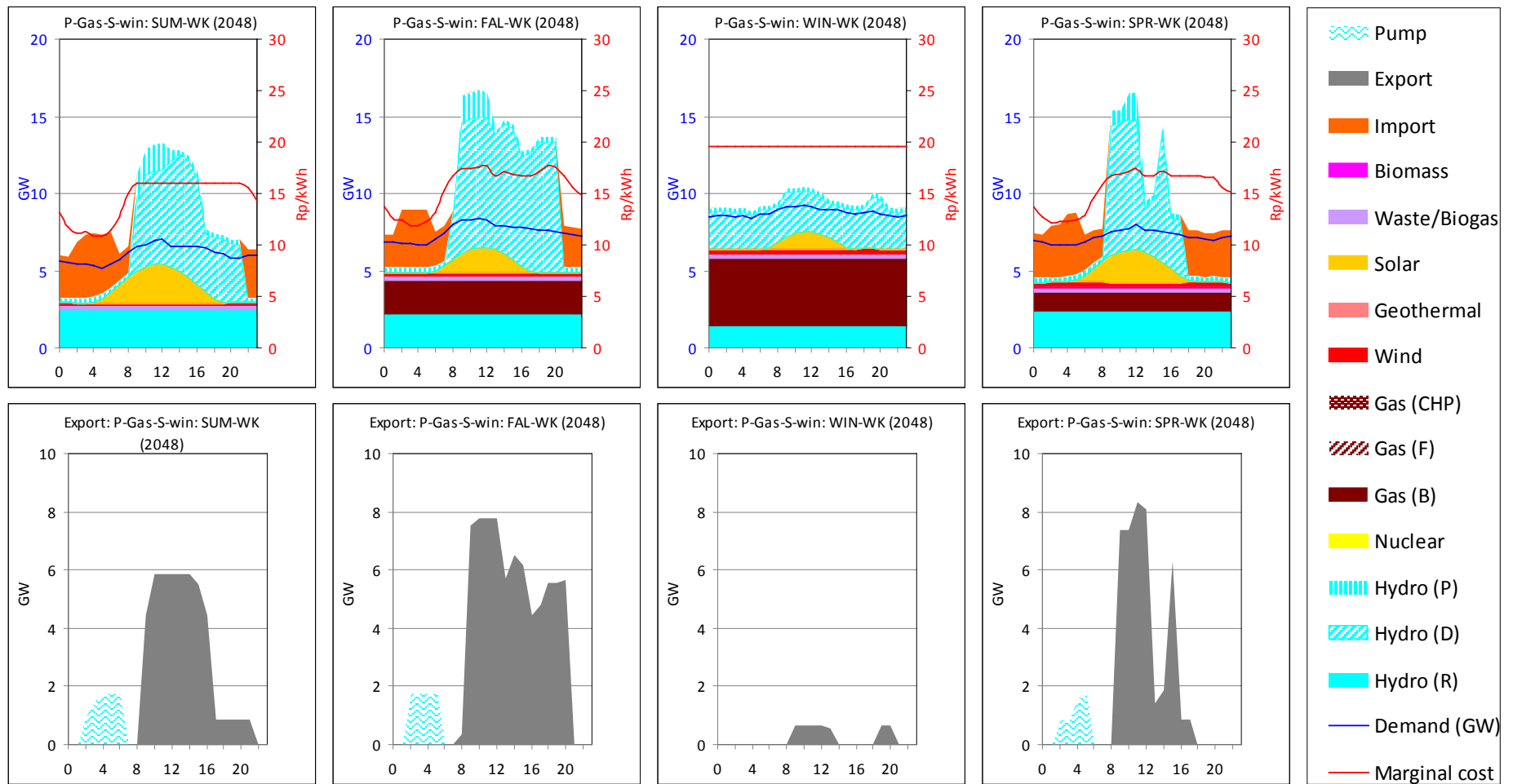


Fig. A-X-70: Electricity generation schedule on weekdays – P-Gas-S-win

Appendix XI: POM demand and gas based electricity supply with security (P-Gas-S)

Tab. A-XI-41: Electricity generation mix: P-Gas-S

Electricity generation mix (PJ): P-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)					41	67	50
Gas (CHP)	3		3	18	0		
Gas (Flex)	0						
Nuclear	91	94	82	63	14		
Hydro	135	133	139	136	140	139	143
Renewable	9	8	8	8	29	28	47
Pumps	-9	-7	-7	-2	-3	-2	-7
Total	229	229	226	224	220	232	233

Renewable electricity generation (PJ): P-Gas-S

Geothermal							
Solar	0	0	0	0	17	17	35
Wind	0	0	0	0	4	3	4
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	29	28	47
Net electricity import, if any	2						

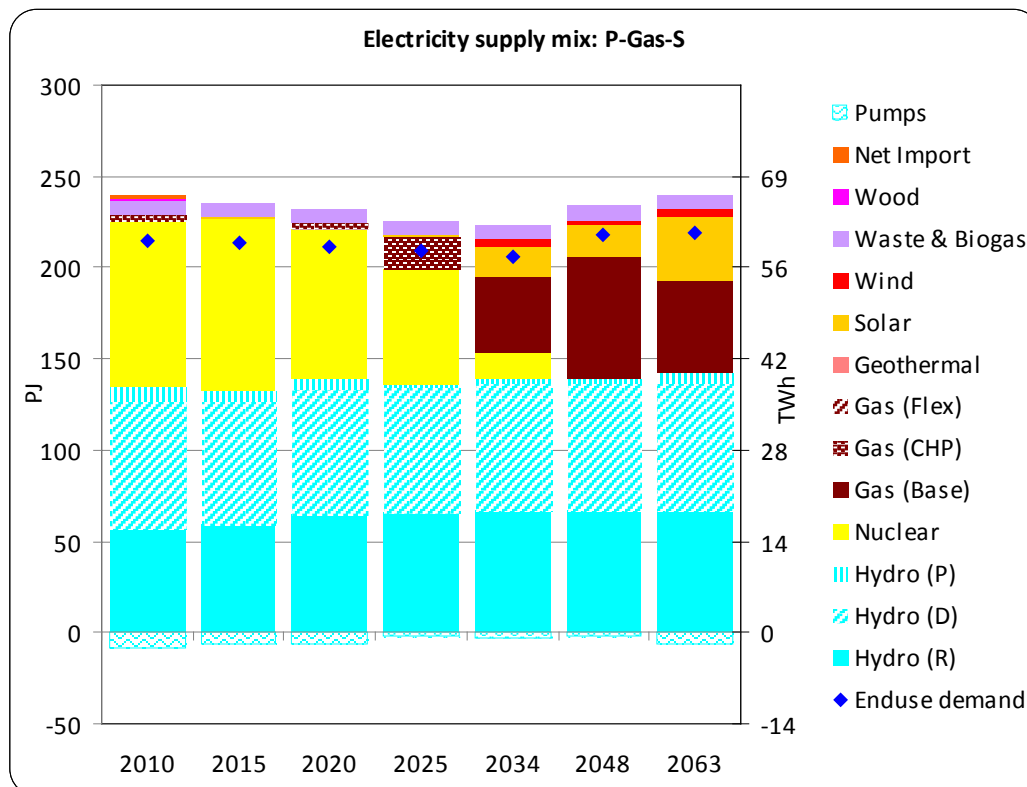


Fig. A-XI-71: Electricity generation mix – P-Gas-S

Tab. A-XI-42: Installed capacity – P-Gas-S

Installed Capacity (GW): P-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)					4.1	5.5	4.8
Gas (CHP)	0.2	0.2	1.0	1.1	0.9		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.3	13.7	13.4	13.8	13.9	14.6
Renewable	0.7	0.6	0.7	1.0	7.0	6.7	12.4
Total	17.3	17.4	18.2	17.7	26.3	26.1	31.7

Renewable Capacity (GW): P-Gas-S

Geothermal							
Solar	0.0	0.0	0.0	0.0	4.9	4.9	10.2
Wind	0.0	0.0	0.0	0.0	0.9	0.7	1.0
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	7.0	6.7	12.4

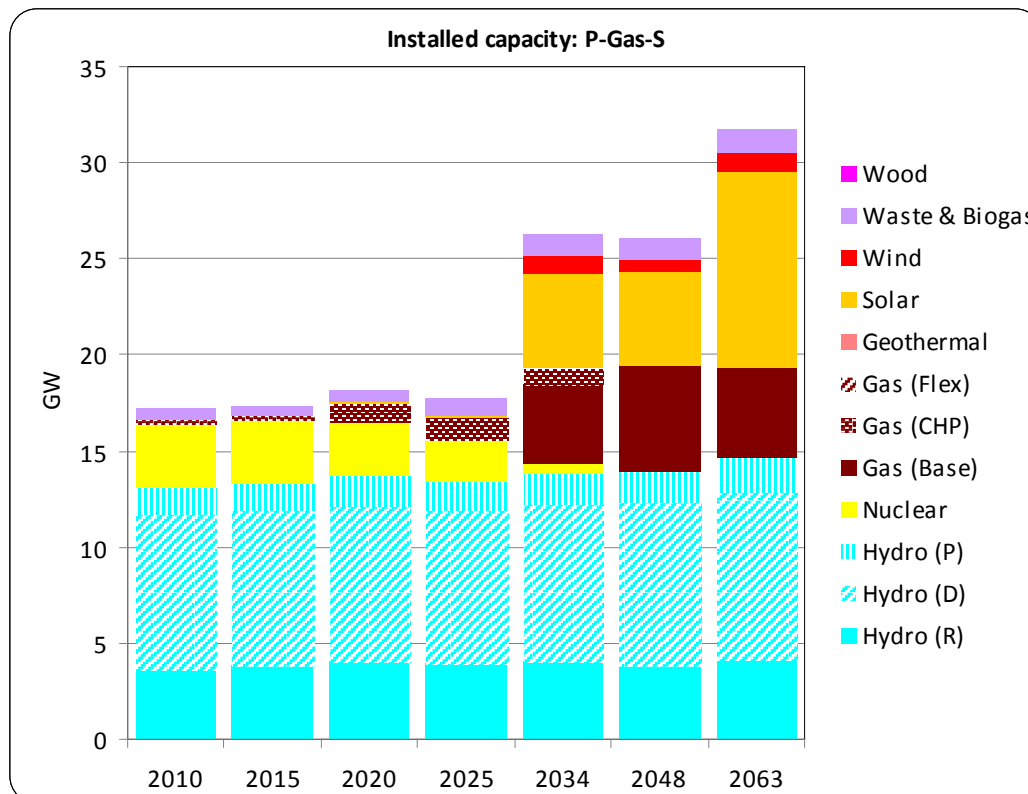


Fig. A-XI-72: Installed capacity – P-Gas-S

Tab. A-XI-43: Annual undiscounted system cost by category – P-Gas-S

Undiscounted system cost (Billion CHF₂₀₁₀): P-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.3	0.4	0.9	1.0	1.9	1.4
Capital	1.5	1.5	1.8	1.7	2.7	2.4	3.1
Variable O&M	0.8	0.7	0.7	0.7	0.7	0.8	0.8
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.7	0.9	0.8
Trade Balance	-0.3	-0.5	-0.6	-0.4			
Heat credit	-0.3	-0.1	-0.2	-0.5	0.0	0.0	0.0
Total cost	3.4	3.2	3.4	3.8	5.6	6.4	6.5

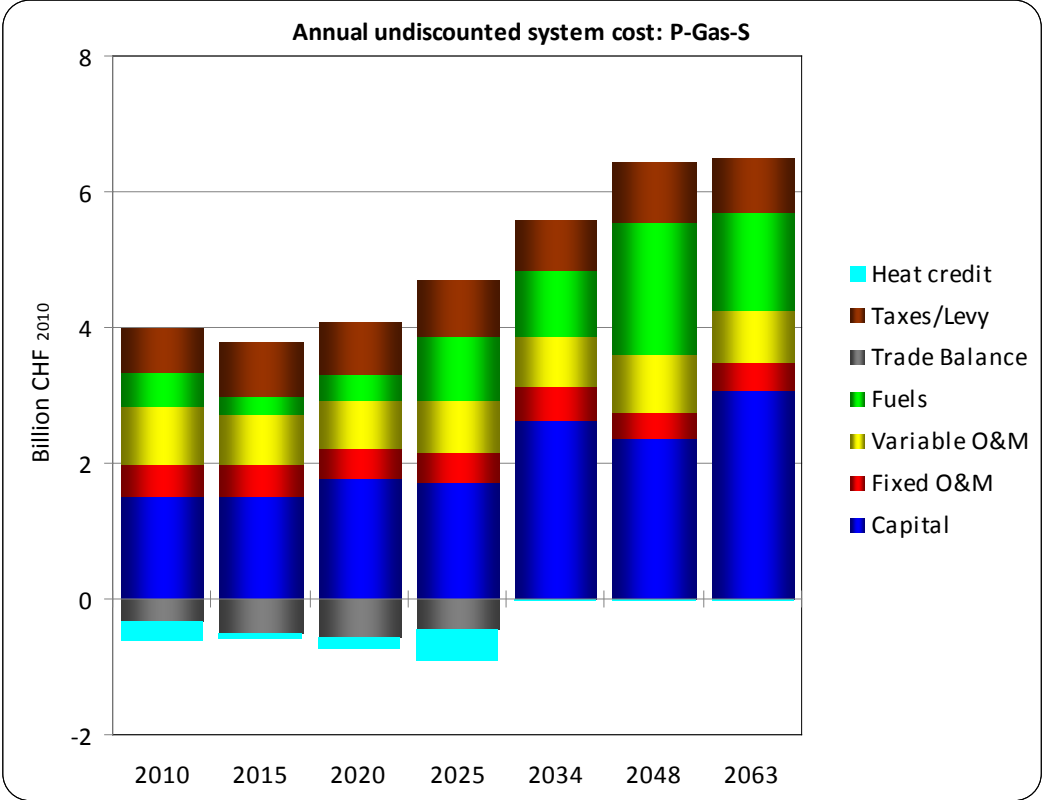


Fig. A-XI-73: Annual undiscounted system cost by cost category – P-Gas-S

Tab. A-XI-44: Annual undiscounted system cost by technology – *P-Gas-S*

Undiscounted system cost (Billion CHF₂₀₁₀): *P-Gas-S*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.6	1.8
Gas	0.2	0.0	0.4	1.3	2.0	3.1	2.4
Nuclear	1.3	1.3	1.1	0.9	0.1	0.1	0.1
Renewable				0.0	0.7	0.7	1.2
Wood	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Waste/Biogas	-0.2	0.0	-0.1	-0.3	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.4	-0.5	-0.4	0.0	0.0	0.0
Total	3.4	3.2	3.4	3.8	5.6	6.4	6.5

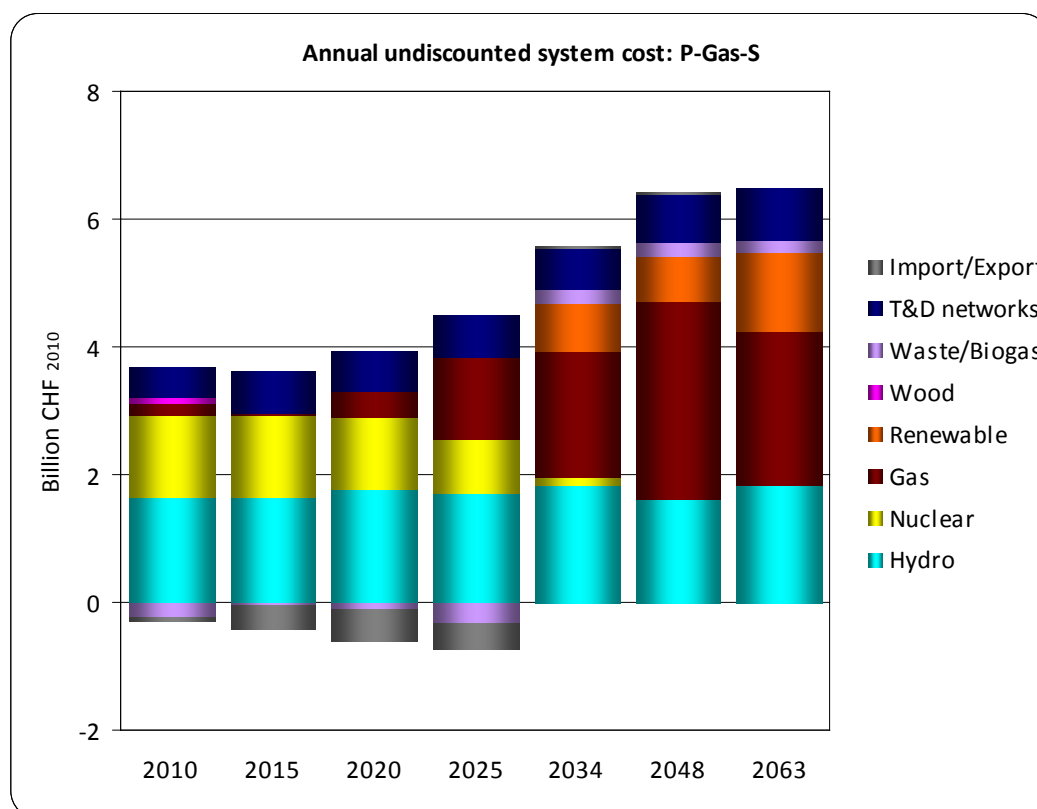


Fig. A-XI-74: Annual undiscounted system cost by technology category – *P-Gas-S*

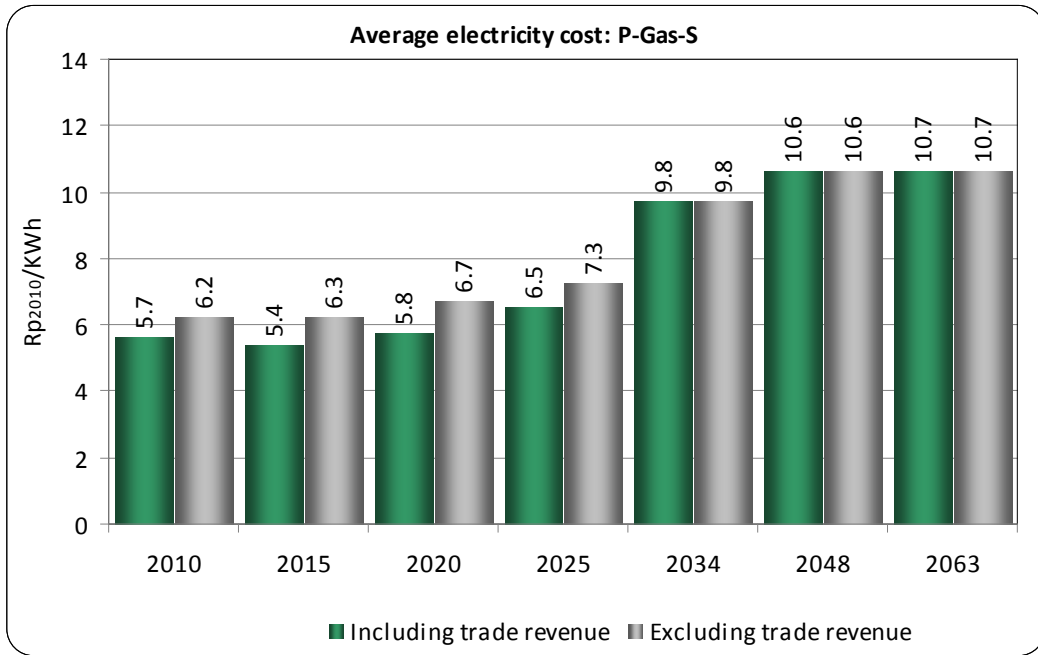


Fig. A-XI-75: Average cost of electricity – P-Gas-S

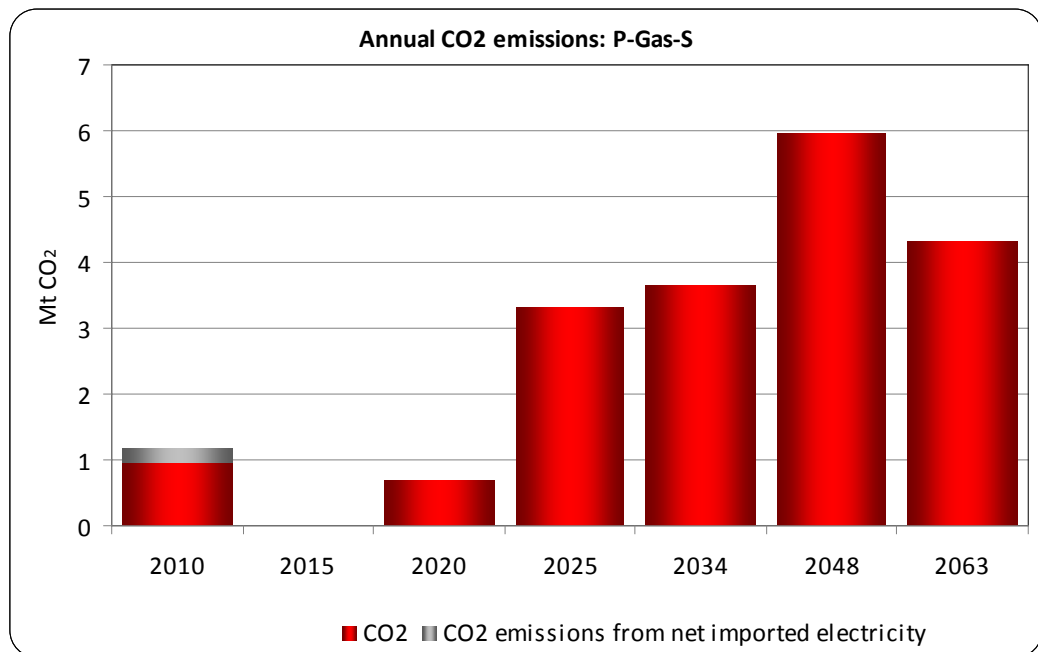


Fig. A-XI-76: Annual CO₂ emissions – P-Gas-S

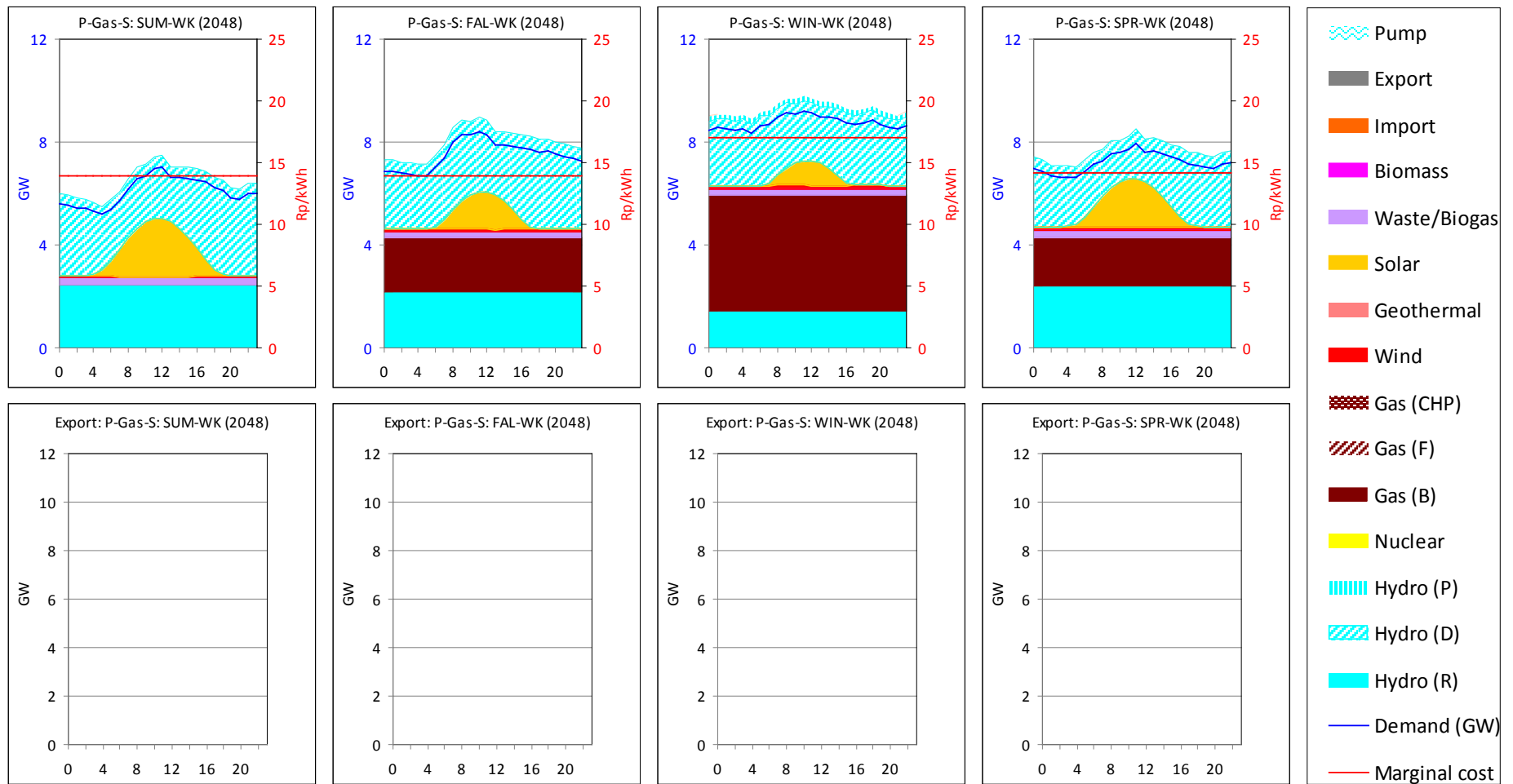


Fig. A-XI-77: Electricity generation schedule on weekdays – P-Gas-S

Appendix XII: POM demand and nuclear electricity supply with security (*P-Ref-S*)

Tab. A-XII-45: Electricity generation mix: *P-Ref-S*

Electricity generation mix (PJ): *P-Ref-S*

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			1	18	9	8	1
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	94	82	63	73	79	90
Hydro	135	133	139	138	133	139	137
Renewable	9	8	8	8	8	8	8
Pumps	-9	-7	-7	-4	-3	-2	-2
Total	229	229	226	224	220	232	233

Renewable electricity generation (PJ): *P-Ref-S*

Geothermal							
Solar	0	0	0	0	0		
Wind	0	0	0	0	0		
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	8	8	8
Net electricity import, if any	2						

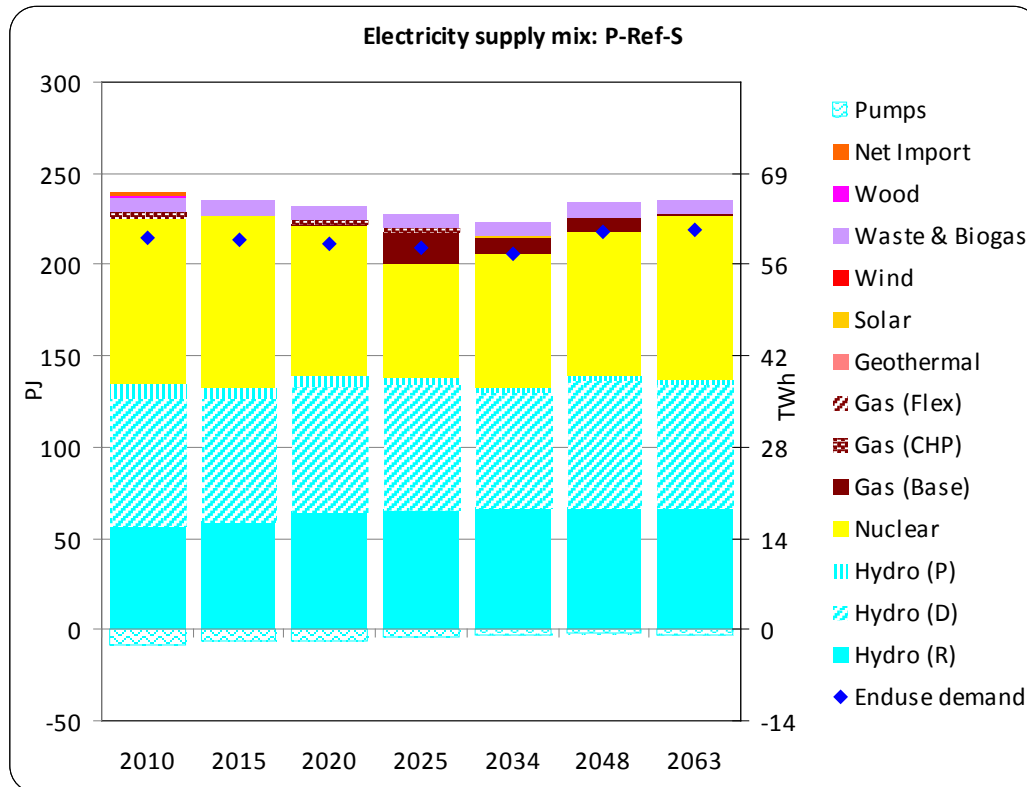


Fig. A-XII-78: Electricity generation mix – *P-Ref-S*

Tab. A-XII-46: Installed capacity – P-Ref-S

Installed Capacity (GW): P-Ref-S

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)		0.2	0.8	1.1	1.5	1.2	0.5
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	3.5	3.6	4.6
Hydro	13.1	13.3	13.7	13.4	12.8	14.4	14.0
Renewable	0.7	0.6	0.7	1.0	1.2	1.2	1.2
Total	17.3	17.6	18.1	17.8	18.9	20.4	20.3

Renewable Capacity (GW): P-Ref-S

Geothermal							
Solar	0.0	0.0	0.0	0.0	0.0		
Wind	0.0	0.0	0.0	0.0	0.0		
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	1.2	1.2	1.2

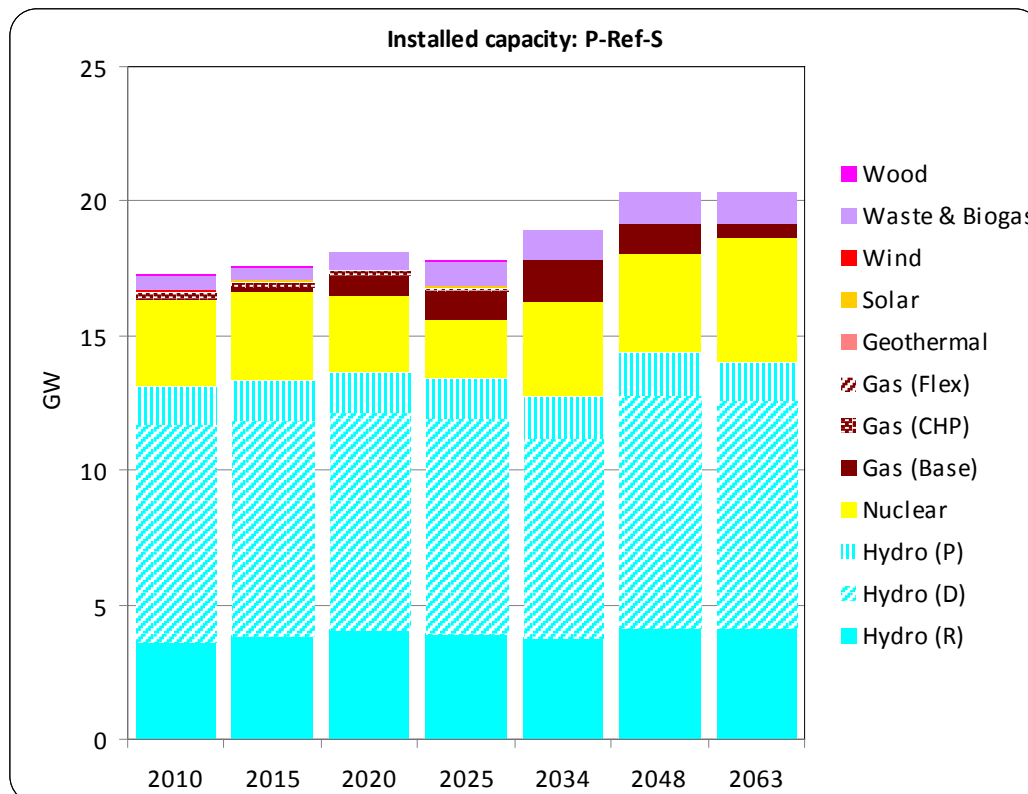


Fig. A-XII-79: Installed capacity – P-Ref-S

Tab. A-XII-47: Annual undiscounted system cost by category – P-Ref-S

Undiscounted system cost (Billion CHF₂₀₁₀): P-Ref-S

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.2	0.4	0.6	0.4	0.4	0.2
Capital	1.5	1.5	1.6	1.6	2.0	2.1	2.4
Variable O&M	0.8	0.7	0.7	0.7	0.5	0.6	0.5
Fixed O&M	0.5	0.5	0.5	0.4	0.4	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.8	0.8	0.8
Trade Balance	-0.3	-0.5	-0.6	-0.5			
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.2	3.6	4.1	4.3	4.3

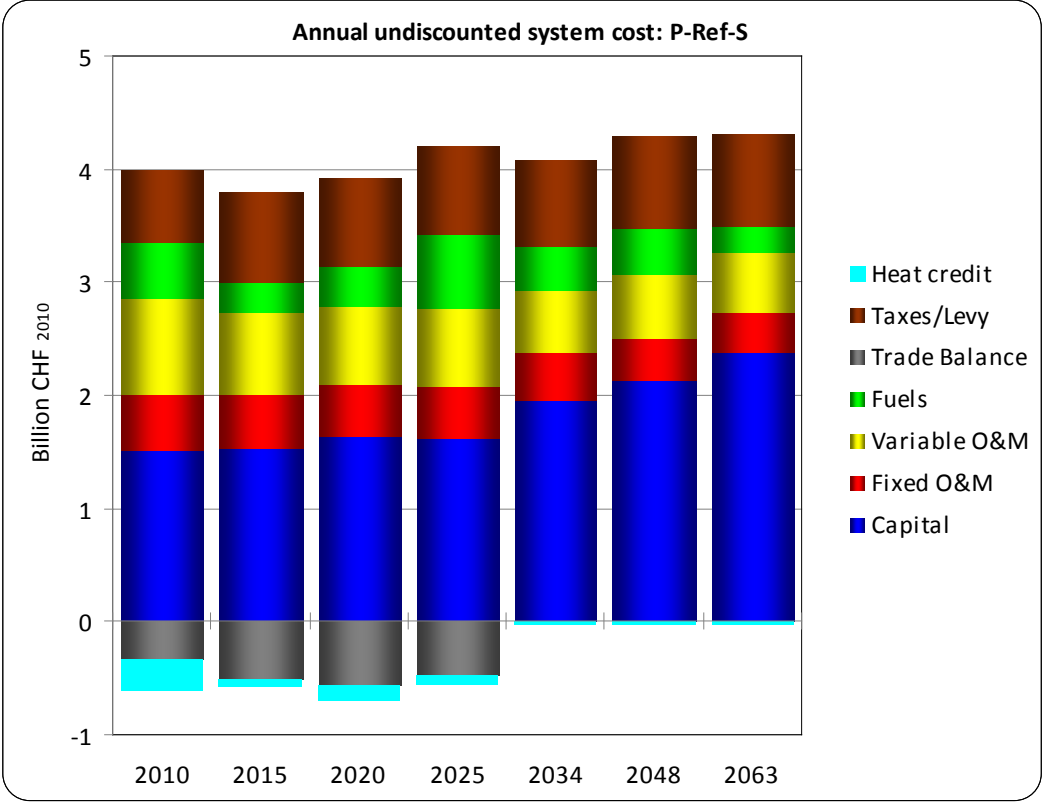


Fig. A-XII-80: Annual undiscounted system cost by cost category – P-Ref-S

Tab. A-XII-48: Annual undiscounted system cost by technology – P-Ref-S

Undiscounted system cost (Billion CHF₂₀₁₀): P-Ref-S

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.7	1.7	1.8
Gas	0.2	0.0	0.2	0.8	0.4	0.4	0.1
Nuclear	1.3	1.3	1.1	0.9	1.0	1.2	1.4
Renewable							
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.7	0.7	0.8	0.8
Import/Export	-0.1	-0.4	-0.5	-0.4	0.0	0.0	
Total	3.4	3.2	3.2	3.6	4.1	4.3	4.3

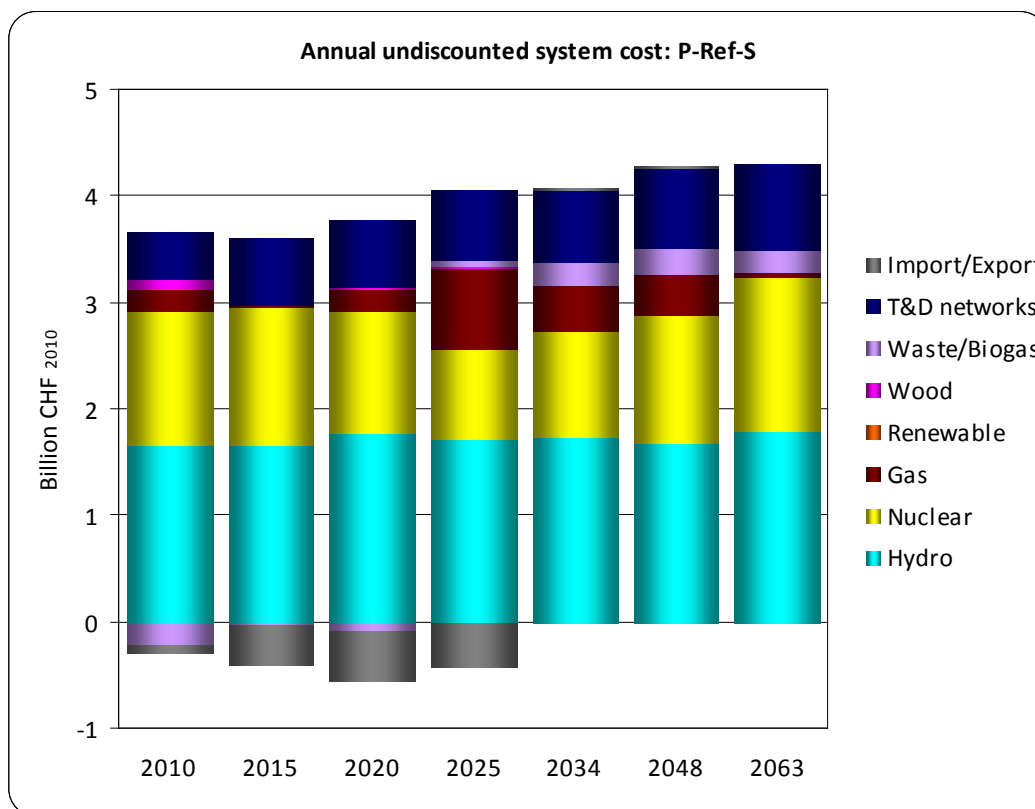


Fig. A-XII-81: Annual undiscounted system cost by technology category – P-Ref-S

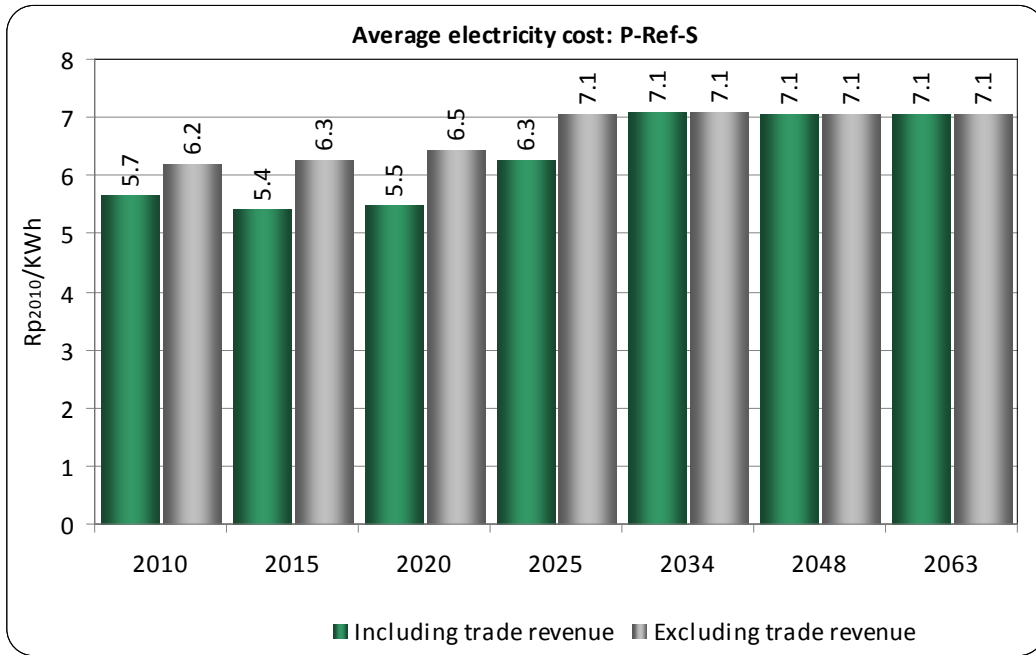


Fig. A-XII-82: Average cost of electricity – P-Ref-S

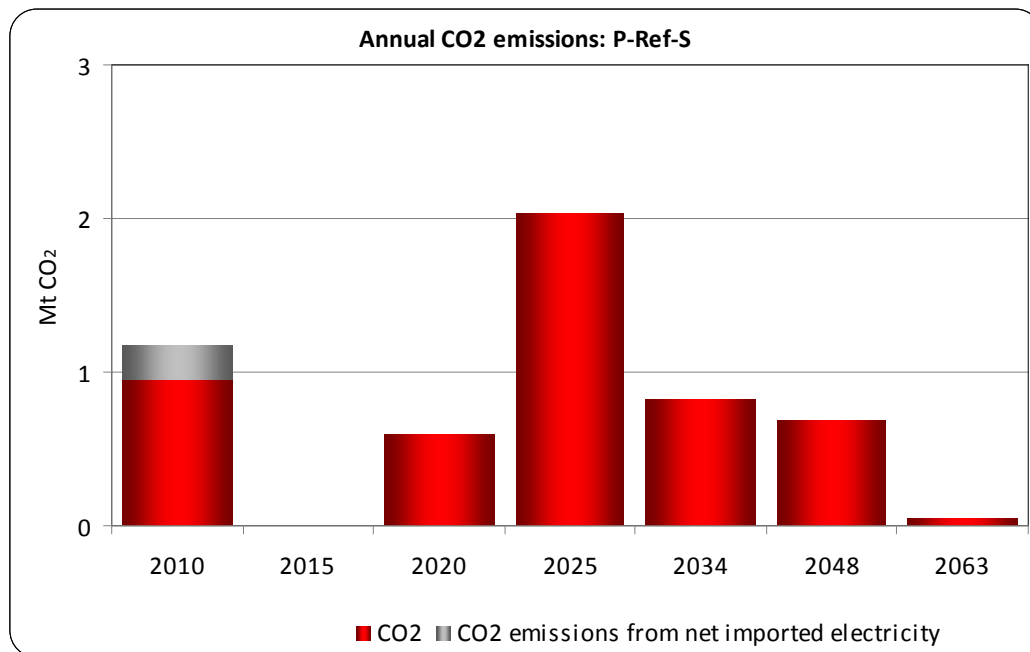


Fig. A-XII-83: Annual CO₂ emissions – P-Ref-S

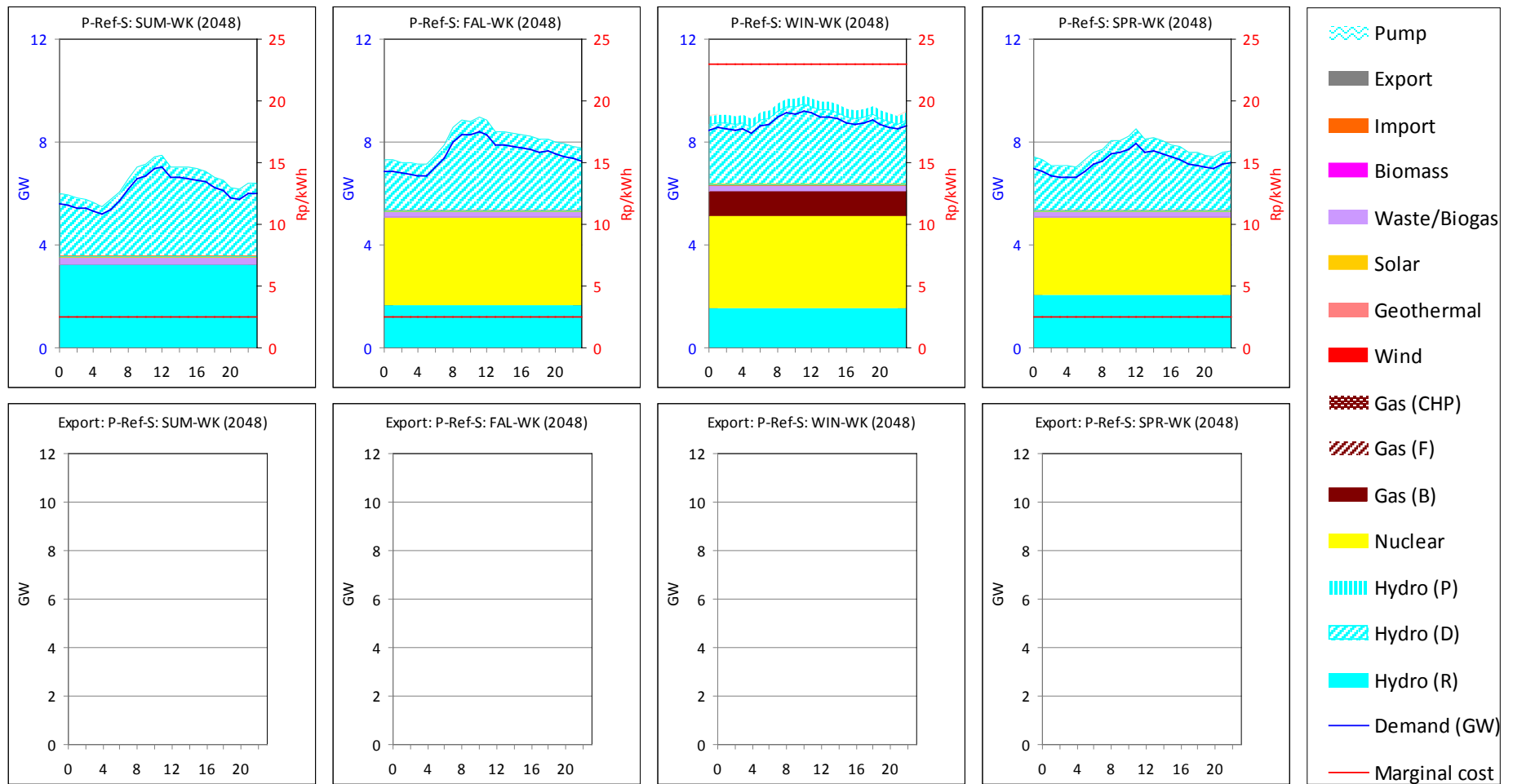


Fig. A-XII-84: Electricity generation schedule on weekdays – P-Ref-S

Appendix XIII: NEP demand and gas based electricity supply with winter security (N-Gas-S-win)

Tab. A-XIII-49: Electricity generation mix: N-Gas-S-win

Electricity generation mix (PJ): N-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			1	14	37	26	23
Gas (CHP)	3		2	1			
Gas (Flex)	0						
Nuclear	91	94	82	63	14		
Hydro	135	134	142	140	147	147	146
Renewable	9	8	8	8	31	44	45
Pumps	-9	-8	-11	-6	-13	-13	-11
Total	229	228	225	220	217	205	203

Renewable electricity generation (PJ): N-Gas-S-Win

Geothermal							
Solar	0	0	0	0	19	28	35
Wind	0	0	0	0	4	9	2
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	31	44	45
Net electricity import, if any	2		0				

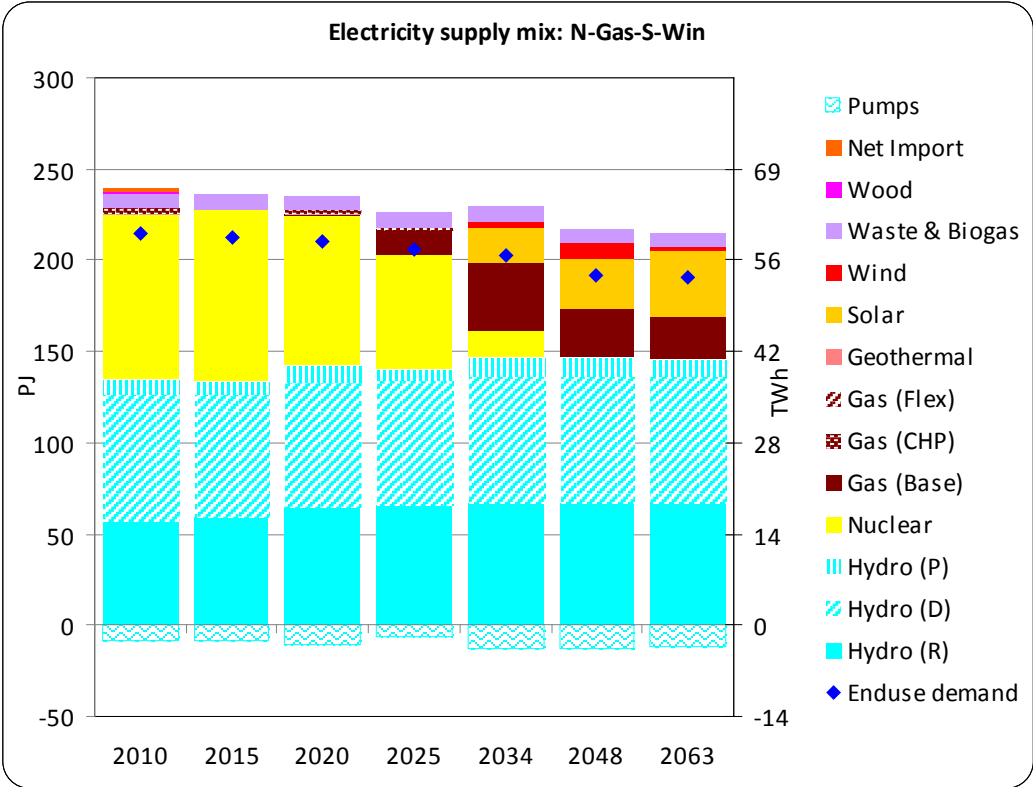


Fig. A-XIII-85: Electricity generation mix – N-Gas-S-win

Tab. A-XIII-50: Installed capacity – N-Gas-S-win

Installed Capacity (GW): N-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)			0.2	0.6	3.0	3.9	3.8
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.4	13.8	13.6	13.8	14.1	14.4
Renewable	0.7	0.6	0.7	1.0	7.6	11.1	11.8
Total	17.3	17.4	17.7	17.4	24.9	29.1	30.0

Renewable Capacity (GW): N-Gas-S-Win

Geothermal							
Solar	0.0	0.0	0.0	0.0	5.5	8.0	10.2
Wind	0.0	0.0	0.0	0.0	0.9	2.0	0.5
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.6	0.7	1.0	7.6	11.1	11.8

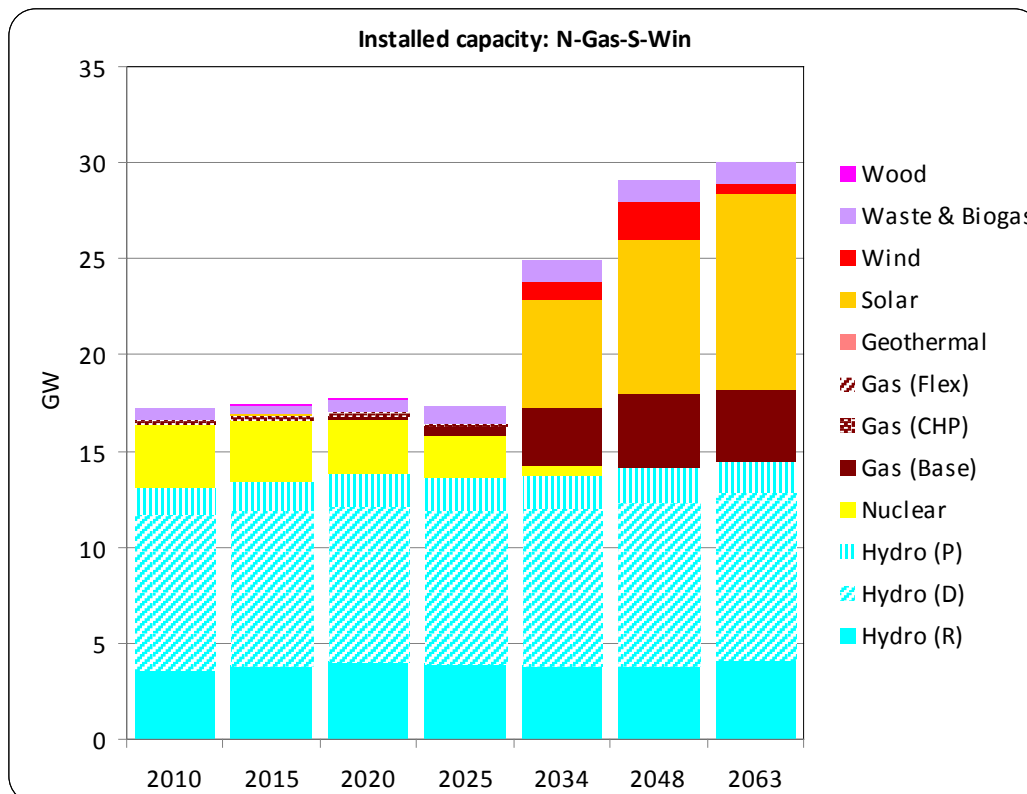


Fig. A-XIII-86: Installed capacity – N-Gas-S-win

Tab. A-XIII-51: Annual undiscounted system cost by category – N-Gas-S-win

Undiscounted system cost (Billion CHF₂₀₁₀): N-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.2	0.4	0.6	0.9	0.7	0.7
Capital	1.5	1.5	1.6	1.7	2.6	3.0	3.3
Variable O&M	0.8	0.7	0.7	0.7	0.8	0.7	0.6
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.5	0.4
Taxes/Levy	0.6	0.8	0.8	0.8	0.9	0.8	0.7
Trade Balance	-0.3	-0.5	-0.7	-0.8	-1.1	-1.0	-1.0
Heat credit	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.2	3.1	3.3	4.6	4.6	4.8

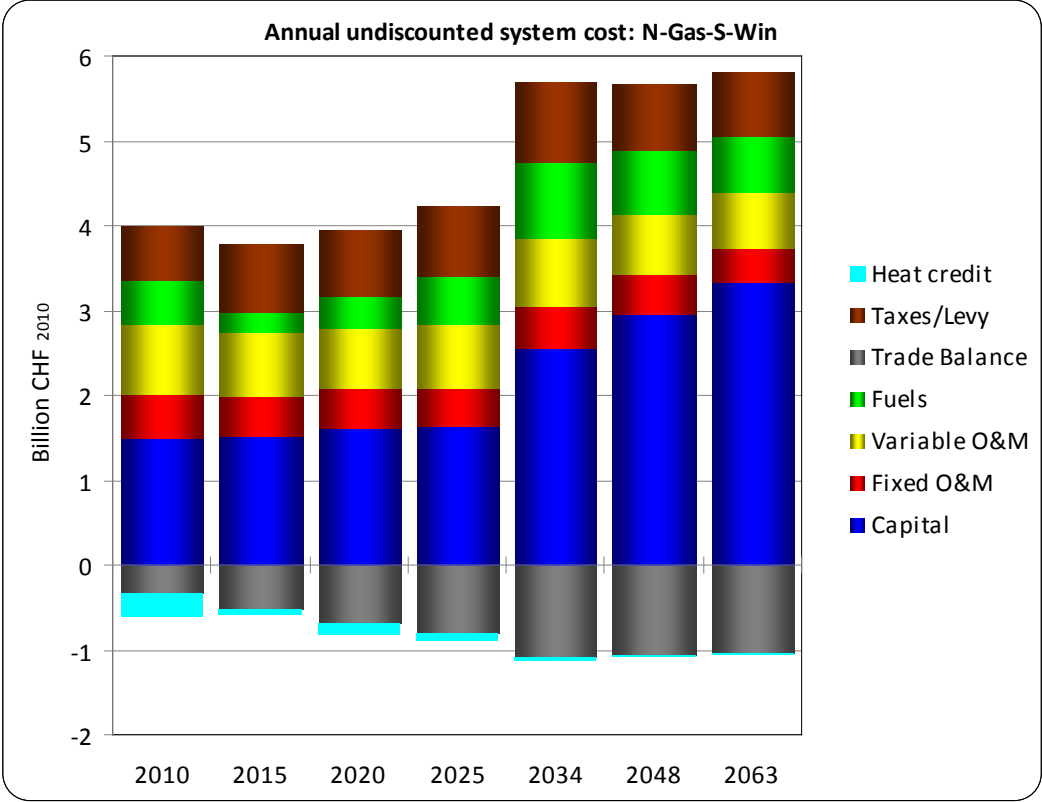


Fig. A-XIII-87: Annual undiscounted system cost by cost category – N-Gas-S-win

Tab. A-XIII-52: Annual undiscounted system cost by technology – *N-Gas-S-win*

Undiscounted system cost (Billion CHF₂₀₁₀): *N-Gas-S-Win*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.8	1.6	1.8
Gas	0.2	0.0	0.2	0.7	1.8	1.5	1.4
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	0.8	1.3	1.2
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Import/Export	-0.1	-0.4	-0.6	-0.6	-0.9	-0.7	-0.6
Total	3.4	3.2	3.1	3.3	4.6	4.6	4.8

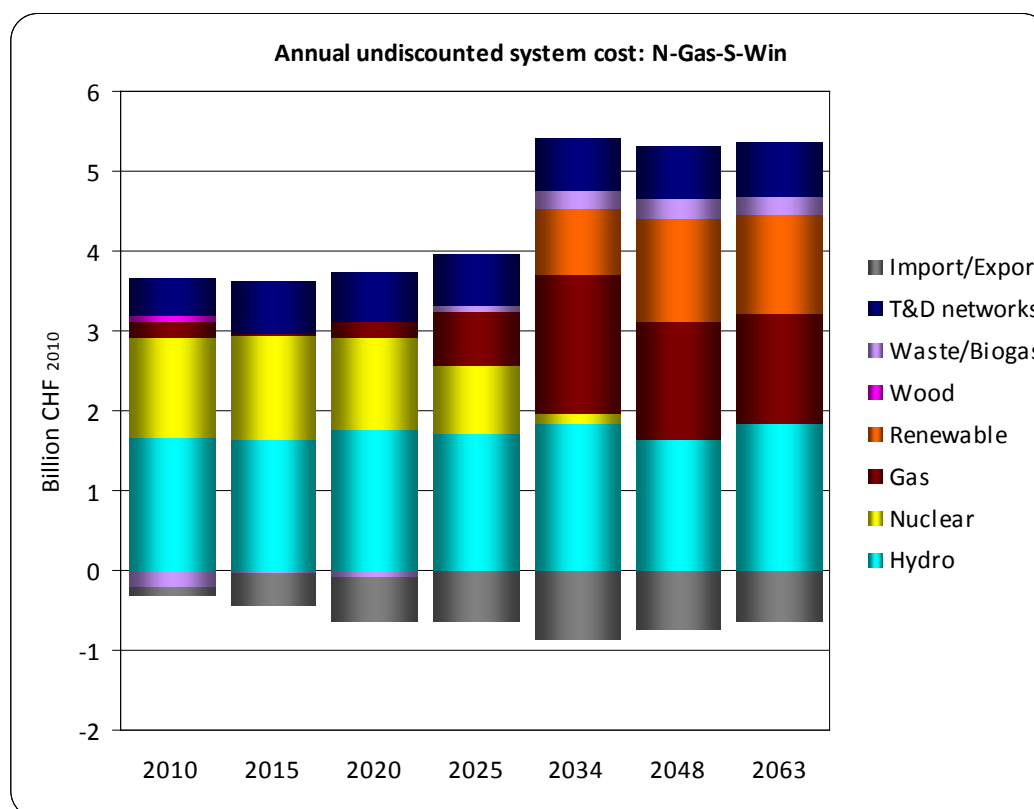


Fig. A-XIII-88: Annual undiscounted system cost by technology category – *N-Gas-S-win*

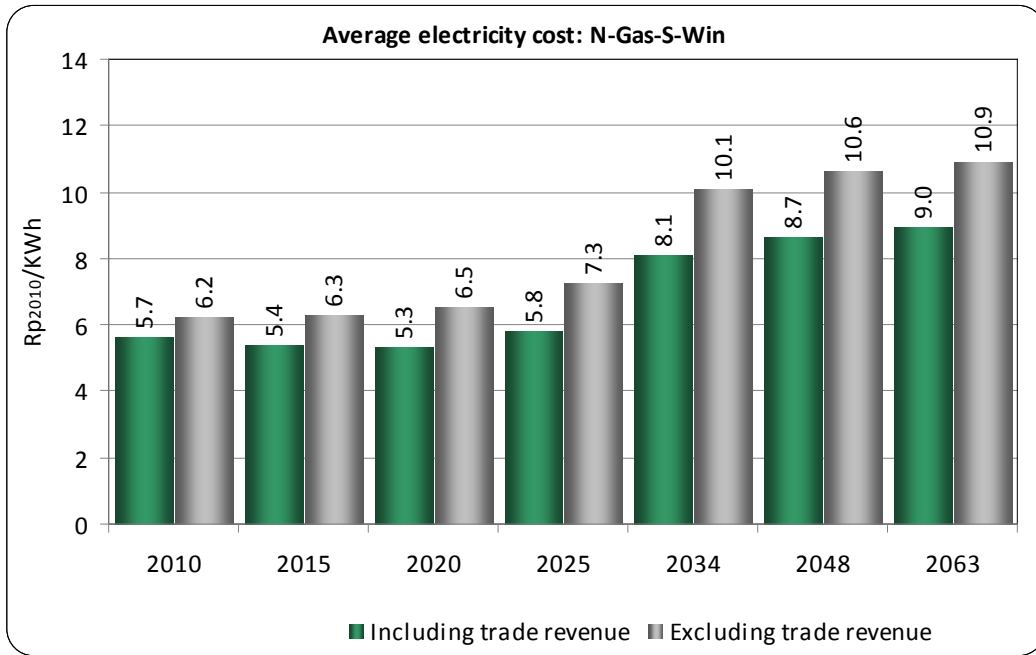


Fig. A-XIII-89: Average cost of electricity – N-Gas-S-win

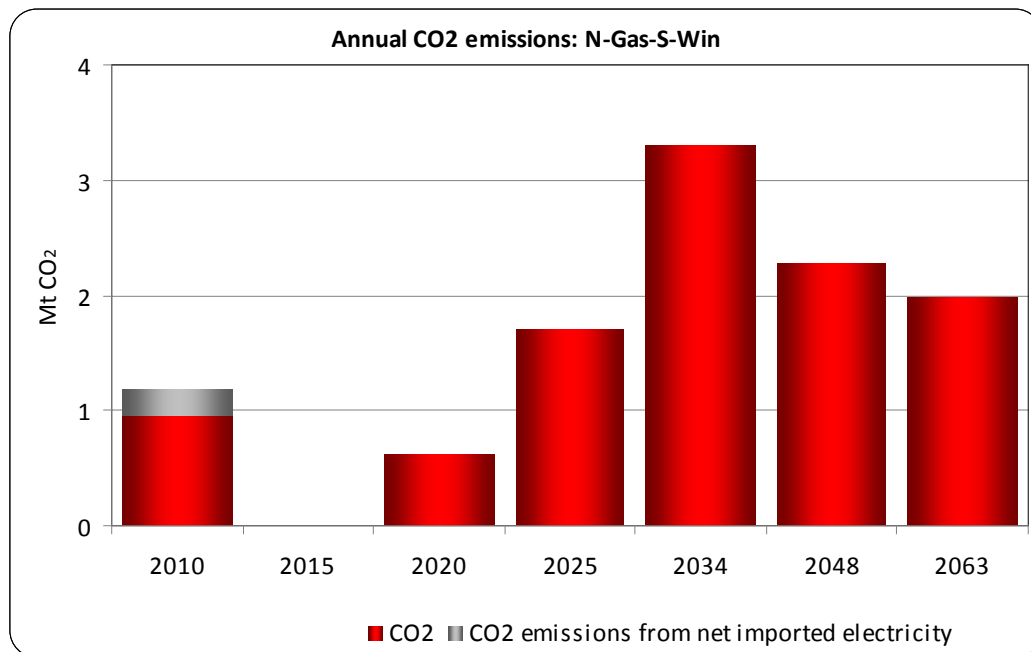


Fig. A-XIII-90: Annual CO₂ emissions – N-Gas-S-win

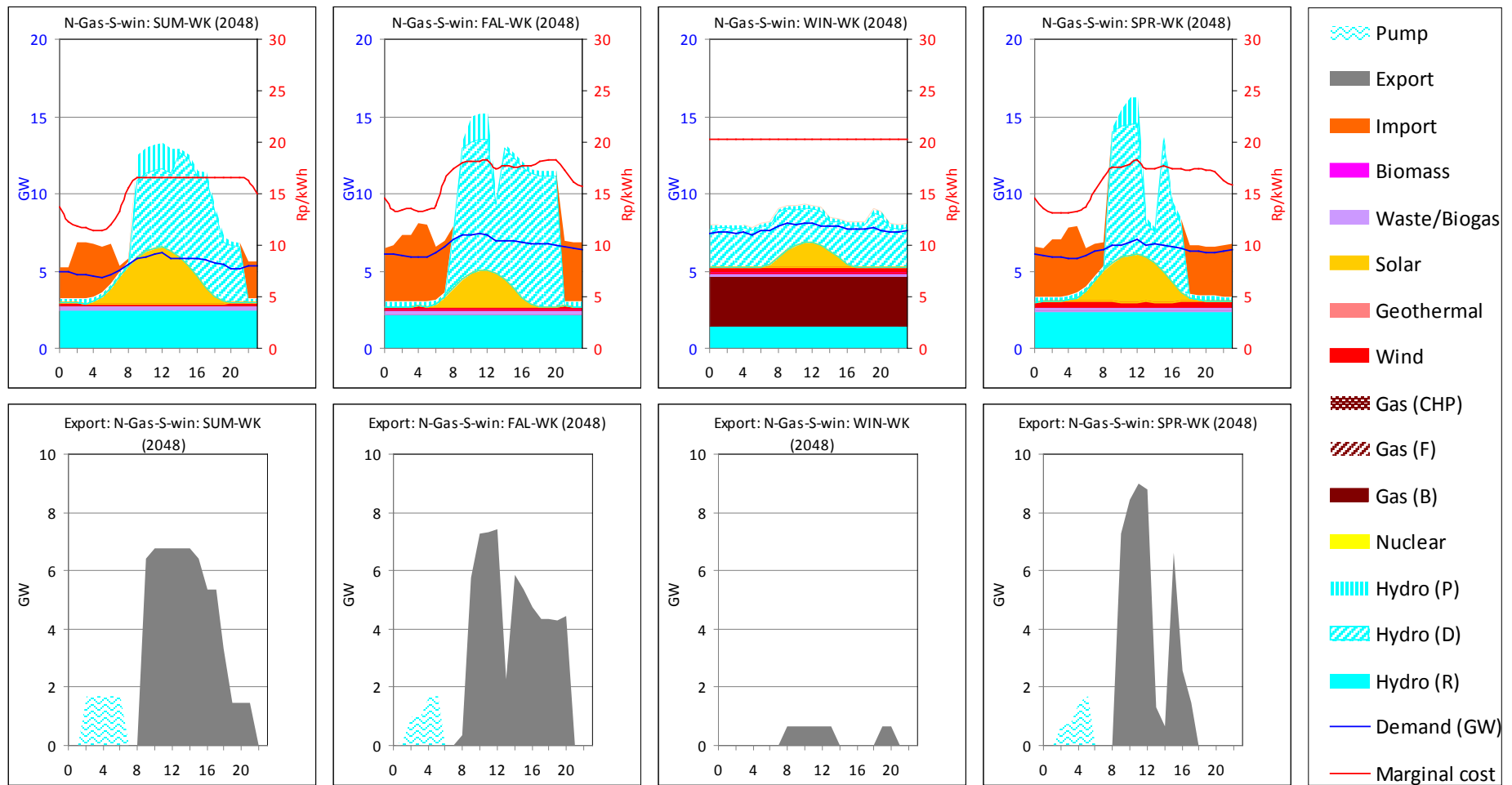


Fig. A-XIII-91: Electricity generation schedule on weekdays – N-Gas-S-win

Appendix XIV: NEP demand and gas based electricity supply with supply security (N-Gas-S)

Tab. A-XIV-53: Electricity generation mix: N-Gas-S

Electricity generation mix (PJ): N-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)					37	31	25
Gas (CHP)	3		2	12	0		
Gas (Flex)	0						
Nuclear	91	94	82	63	14		
Hydro	135	133	139	135	140	141	143
Renewable	9	8	9	10	29	37	42
Pumps	-9	-7	-7		-4	-5	-8
Total	229	228	225	220	217	205	203

Renewable electricity generation (PJ): N-Gas-S

Geothermal			1	2	2	1	
Solar	0	0	0	0	19	19	32
Wind	0	0	0	0	0	9	3
Waste & Biogas	8	7	8	8	8	8	8
Wood	1			0			
Total renewable	9	8	9	10	29	37	42
Net electricity import, if any	2						

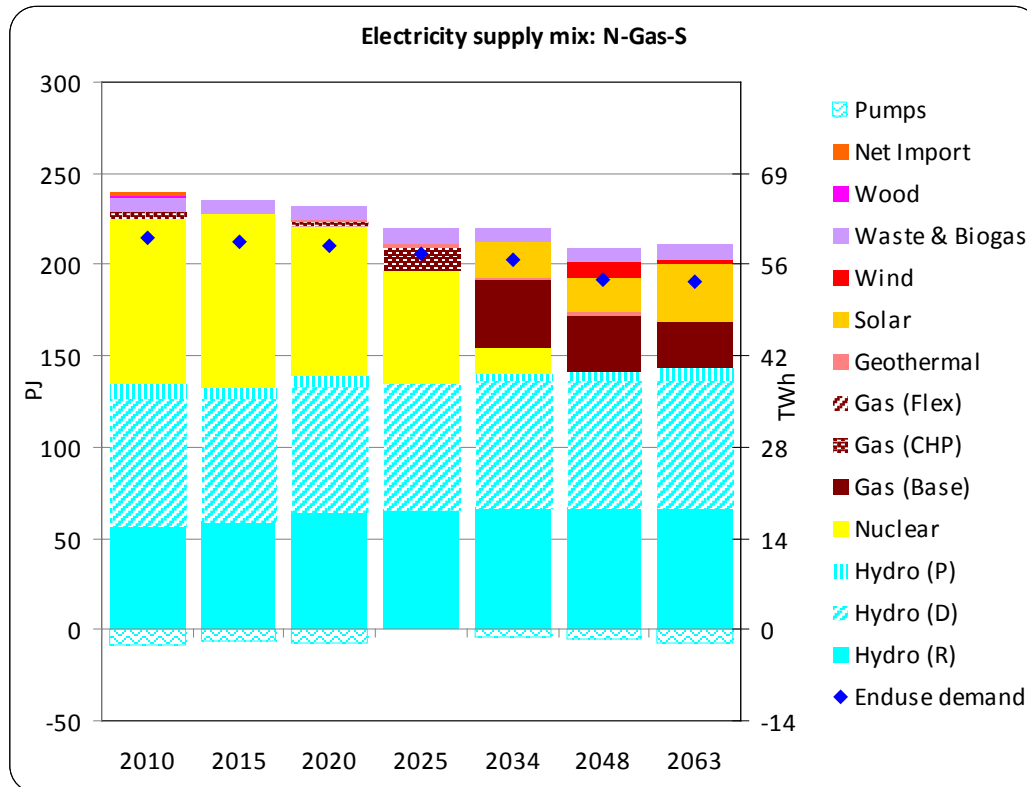


Fig. A-XIV-92: Electricity generation mix – N-Gas-S

Tab. A-XIV-54: Installed capacity – N-Gas-S

Installed Capacity (GW): N-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)					4.1	5.5	4.3
Gas (CHP)	0.2	0.2	0.7	0.8	0.6		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.3	13.7	13.4	13.9	14.2	15.1
Renewable	0.7	0.5	0.7	1.1	6.8	8.7	12.0
Total	17.3	17.3	17.9	17.4	25.9	28.5	31.5

Renewable Capacity (GW): N-Gas-S

Geothermal			0	0	0	0	
Solar	0.0	0.0	0.0	0.0	5.5	5.5	10.2
Wind	0.0	0.0	0.0	0.0	0.0	2.0	0.7
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0		
Total renewable	0.7	0.5	0.7	1.1	6.8	8.7	12.0

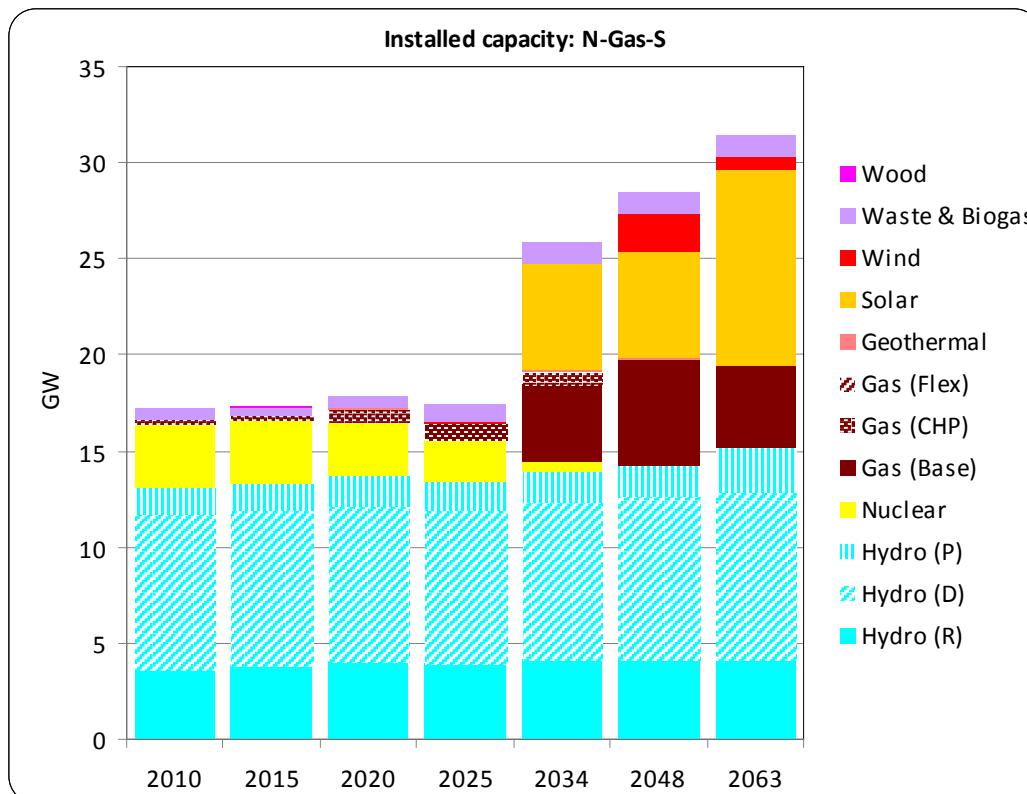


Fig. A-XIV-93: Installed capacity – N-Gas-S

Tab. A-XIV-55: Annual undiscounted system cost by category – N-Gas-S

Undiscounted system cost (Billion CHF₂₀₁₀): N-Gas-S

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.3	0.3	0.7	0.9	0.9	0.7
Capital	1.5	1.5	1.7	1.7	2.6	2.7	3.0
Variable O&M	0.8	0.7	0.7	0.7	0.7	0.7	0.6
Fixed O&M	0.5	0.5	0.5	0.4	0.5	0.4	0.4
Taxes/Levy	0.6	0.8	0.8	0.9	0.9	0.9	0.8
Trade Balance	-0.3	-0.5	-0.6	-0.4			
Heat credit	-0.3	-0.1	-0.1	-0.4	0.0	0.0	0.0
Total cost	3.4	3.2	3.3	3.7	5.6	5.5	5.5

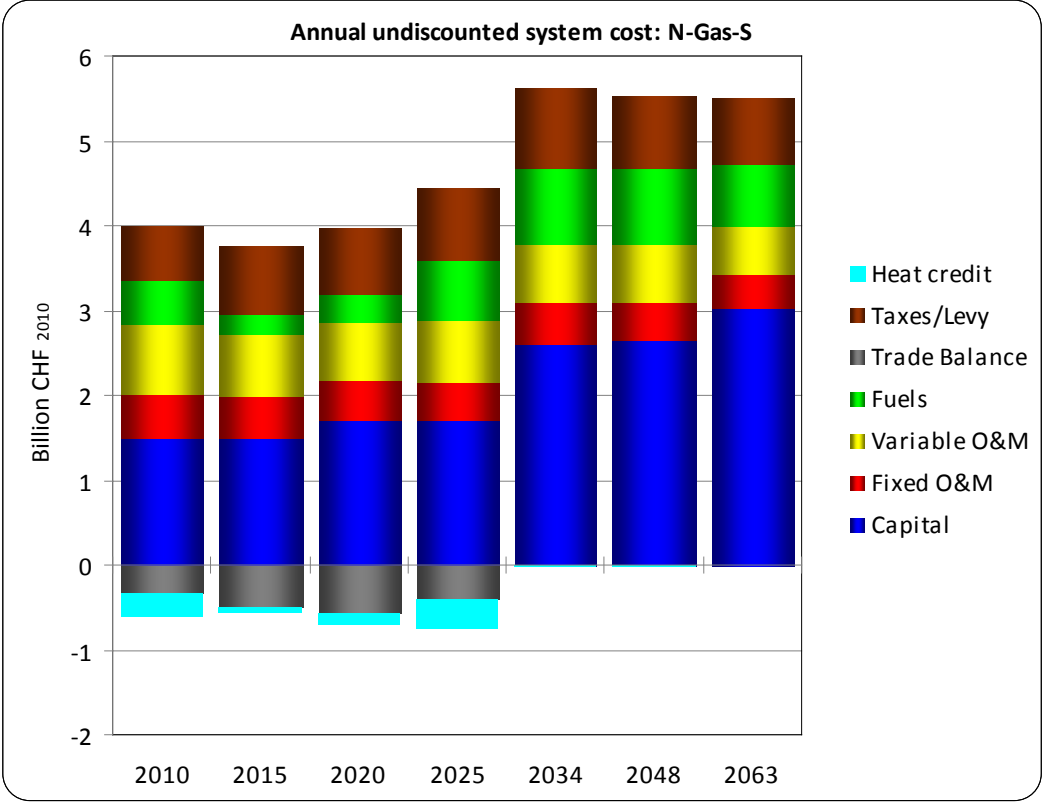


Fig. A-XIV-94: Annual undiscounted system cost by cost category – N-Gas-S

Tab. A-XIV-56: Annual undiscounted system cost by technology – *N-Gas-S*

Undiscounted system cost (Billion CHF₂₀₁₀): *N-Gas-S*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.9
Gas	0.2	0.0	0.3	0.9	2.0	1.9	1.5
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable			0.0	0.1	0.7	1.1	1.2
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	0.0	-0.1	-0.2	0.2	0.2	0.2
T&D networks	0.5	0.6	0.6	0.6	0.7	0.7	0.7
Import/Export	-0.1	-0.4	-0.5	-0.4	0.0	0.0	
Total	3.4	3.2	3.3	3.7	5.6	5.5	5.5

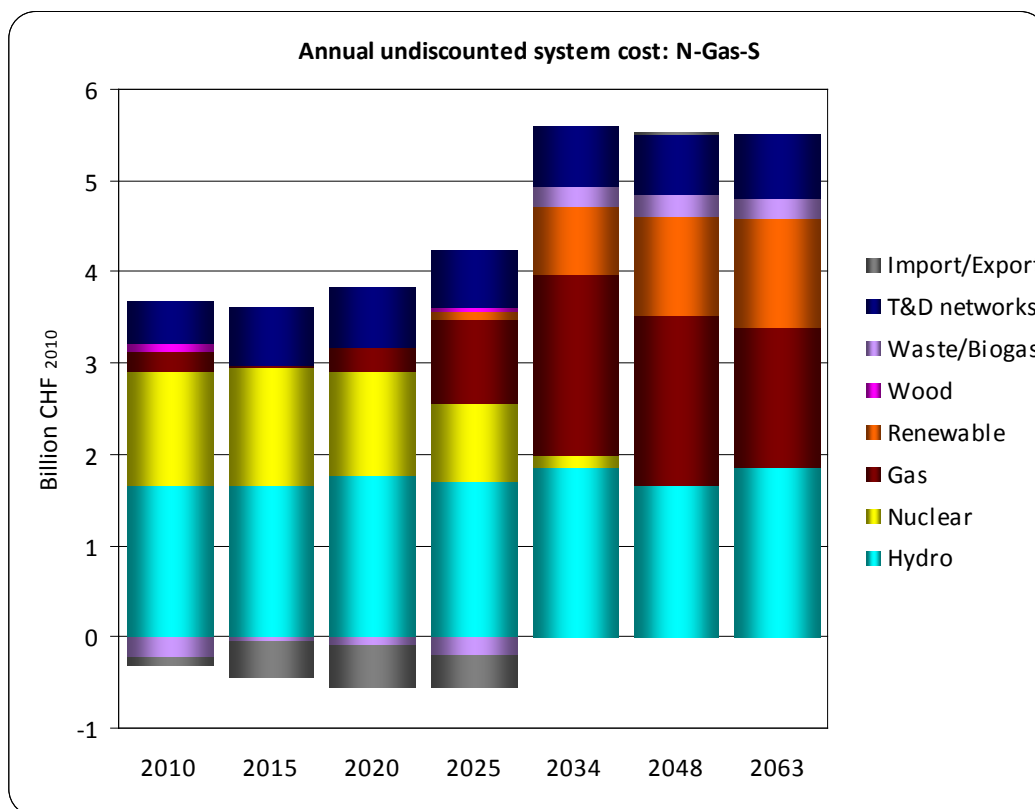


Fig. A-XIV-95: Annual undiscounted system cost by technology category – *N-Gas-S*

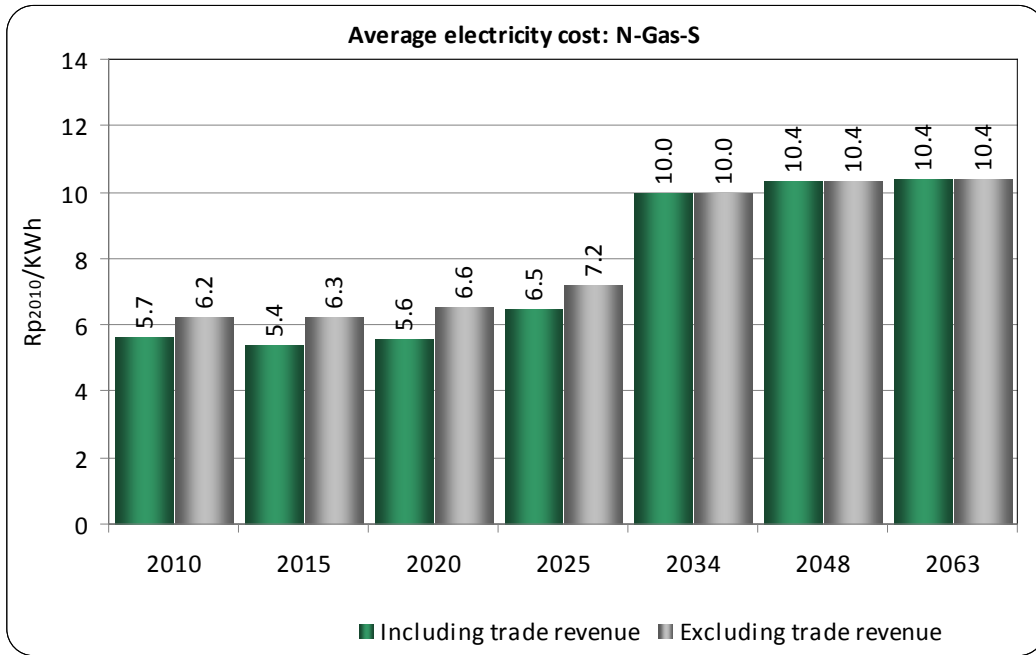


Fig. A-XIV-96: Average cost of electricity – N-Gas-S

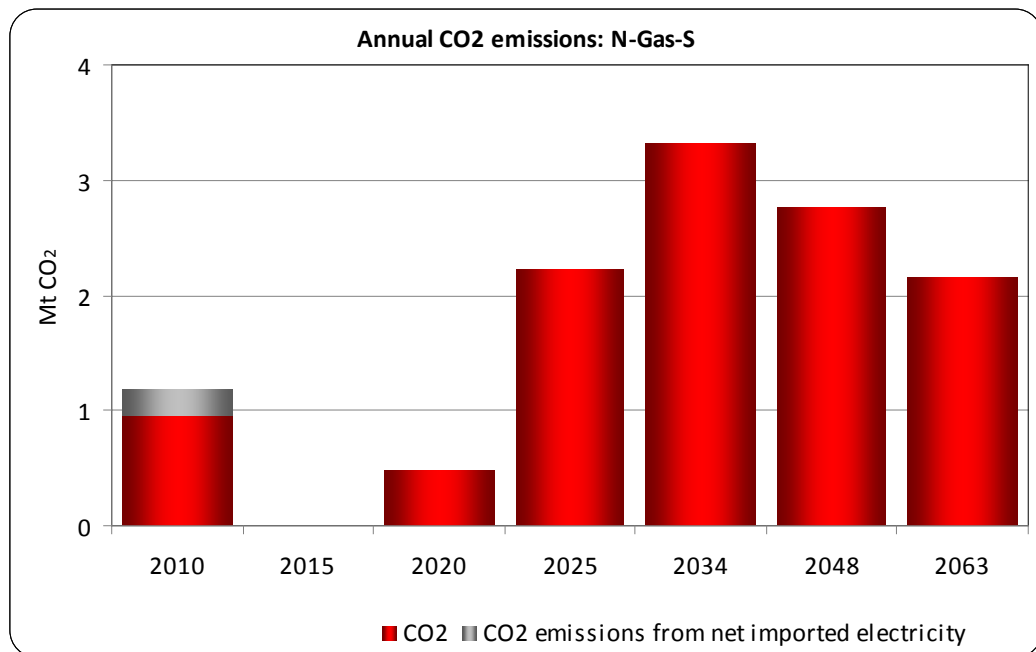


Fig. A-XIV-97: Annual CO₂ emissions – N-Gas-S

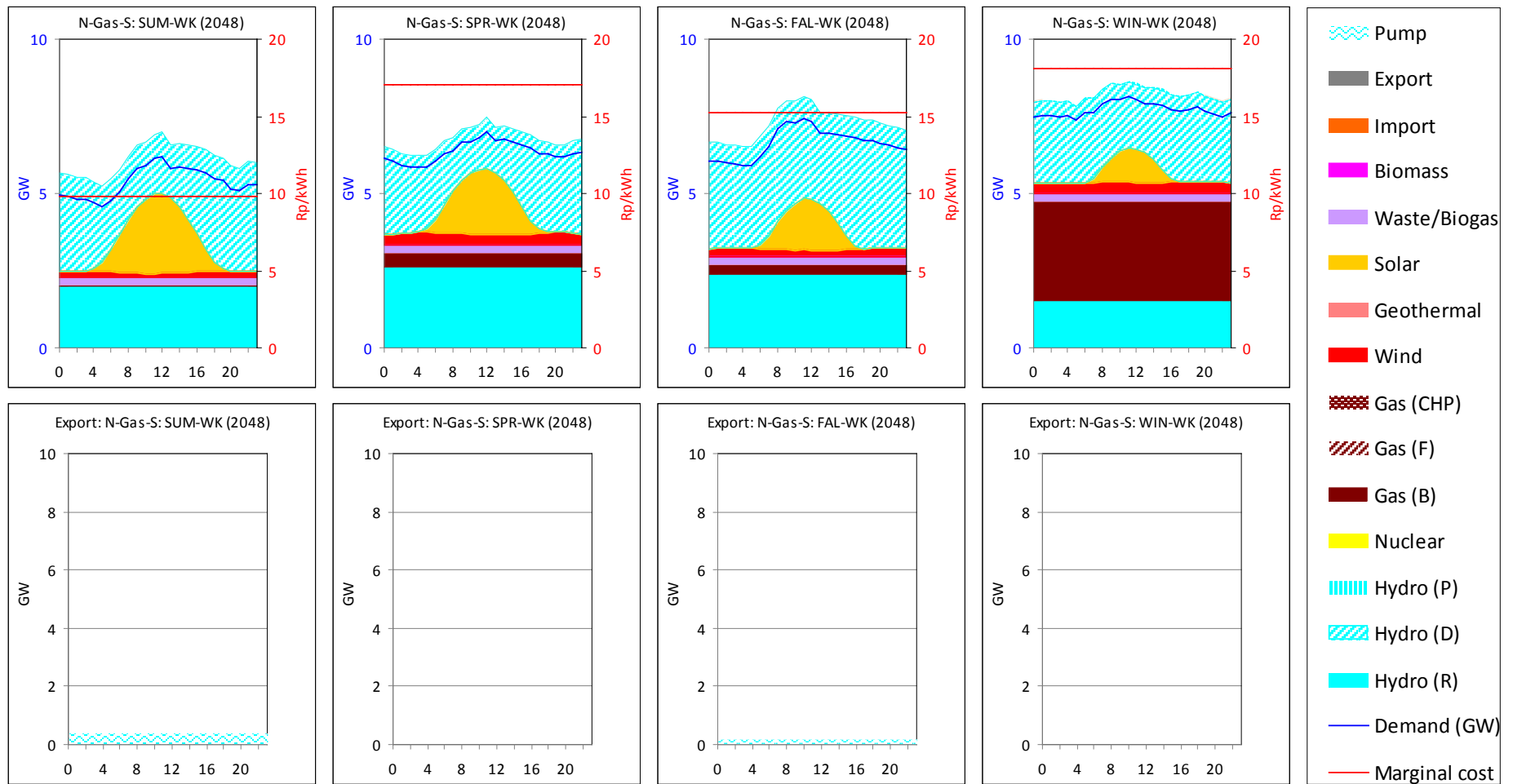


Fig. A-XIV-98: Electricity generation schedule on weekdays – N-Gas-S

Appendix XV: WWB demand and gas electricity based supply with supply security (W-Gas-S)

Tab. A-XV-57: Electricity generation mix: W-Gas-S

Electricity generation mix (PJ): W-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)		1	13	36	65	92	77
Gas (CHP)	3	3	2	1			
Gas (Flex)	0						
Nuclear	91	95	82	63	14		
Hydro	135	130	142	144	148	148	146
Renewable	9	8	8	8	27	36	53
Pumps	-9	-3	-10	-12	-14	-14	-11
Total	229	234	237	240	240	262	265

Renewable electricity generation (PJ): W-Gas-S-Win

Geothermal							
Solar	0	0	0	0	19	19	35
Wind	0	0	0	0	0	9	9
Waste & Biogas	8	8	8	8	8	8	8
Wood	1						
Total renewable	9	8	8	8	27	36	53
Trade balance	2	0	0		0		

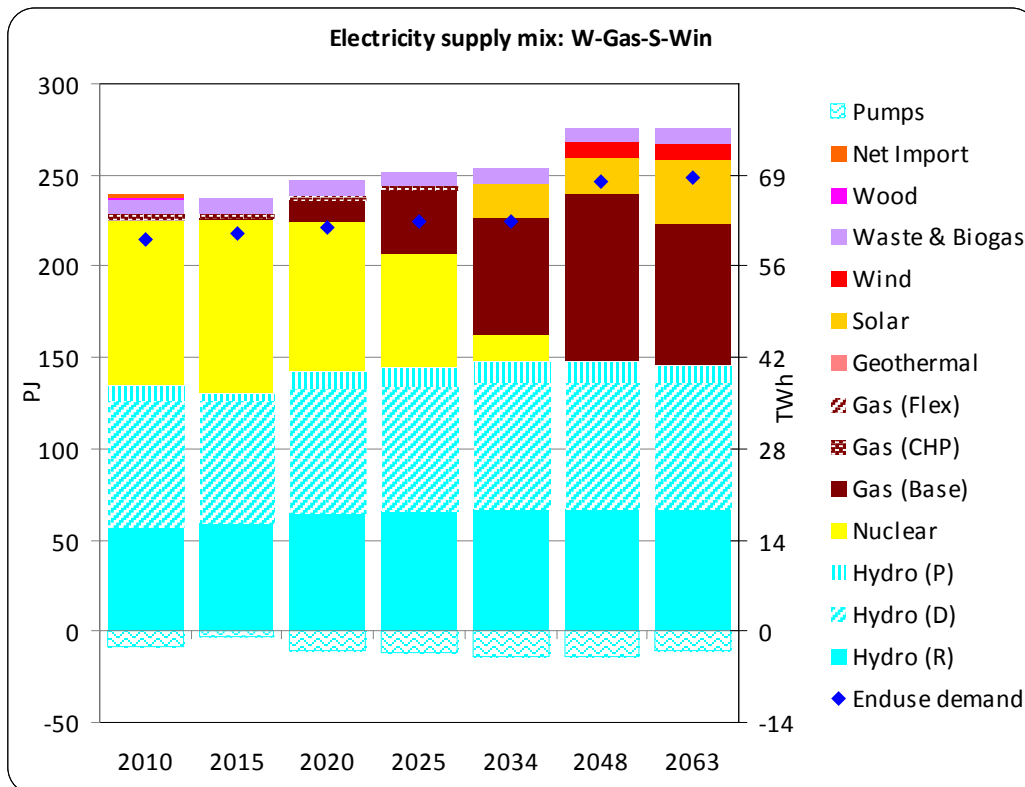


Fig. A-XV-99: Electricity generation mix – W-Gas-S

Tab. A-XV-58: Installed capacity – W-Gas-S

Installed Capacity (GW): W-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Gas (Base)		0.4	1.1	1.4	4.5	6.9	6.2
Gas (CHP)	0.2	0.2	0.1	0.1	0.0		
Gas (Flex)	0.0	0.0	0.0	0.0	0.0		
Nuclear	3.3	3.3	2.8	2.2	0.5		
Hydro	13.1	13.4	13.8	13.6	13.8	14.1	14.1
Renewable	0.7	0.6	0.7	1.0	6.7	8.7	13.5
Total	17.3	17.8	18.6	18.2	25.5	29.7	33.8

Renewable Capacity (GW): W-Gas-S-Win

Geothermal							
Solar	0.0	0.0	0.0	0.0	5.5	5.5	10.2
Wind	0.0	0.0	0.0	0.0	0.0	2.0	2.1
Waste & Biogas	0.6	0.5	0.6	0.9	1.2	1.2	1.2
Wood	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total renewable	0.7	0.6	0.7	1.0	6.7	8.7	13.5

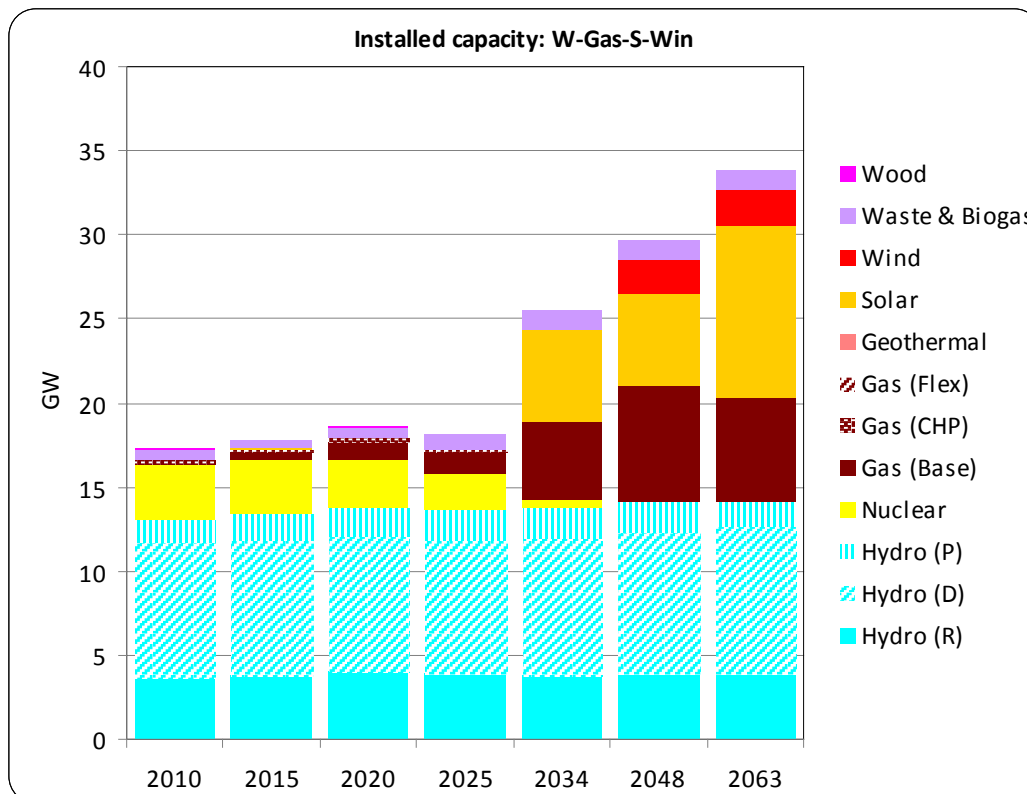


Fig. A-XV-100: Installed capacity – W-Gas-S

Tab. A-XV-59: Annual undiscounted system cost by category – W-Gas-S

Undiscounted system cost (Billion CHF₂₀₁₀): W-Gas-S-Win

	2010	2015	2020	2025	2034	2048	2063
Fuels	0.5	0.4	0.6	1.1	1.6	2.7	2.2
Capital	1.5	1.5	1.7	1.7	2.6	3.0	3.6
Variable O&M	0.8	0.7	0.8	0.9	1.0	1.2	1.1
Fixed O&M	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Taxes/Levy	0.6	0.8	0.8	0.9	0.9	1.1	1.0
Trade Balance	-0.3	-0.5	-0.7	-0.8	-1.1	-1.1	-1.0
Heat credit	-0.3	-0.2	-0.1	-0.1	0.0	0.0	0.0
Total cost	3.4	3.3	3.6	4.1	5.3	7.3	7.4

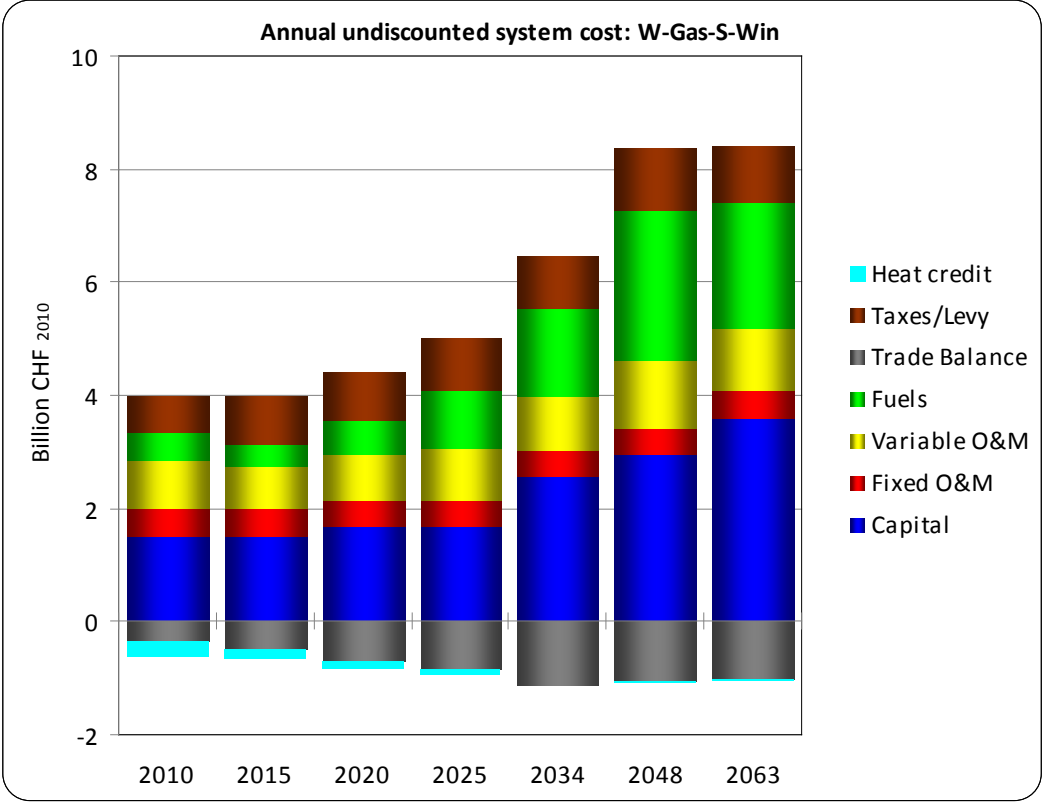


Fig. A-XV-101: Annual undiscounted system cost by cost category – W-Gas-S

Tab. A-XV-60: Annual undiscounted system cost by technology – *W-Gas-S*

Undiscounted system cost (Billion CHF₂₀₁₀): *W-Gas-S-Win*

	2010	2015	2020	2025	2034	2048	2063
Hydro	1.7	1.7	1.8	1.7	1.9	1.7	1.8
Gas	0.2	0.2	0.6	1.4	2.6	4.3	3.6
Nuclear	1.3	1.3	1.1	0.9	0.1		
Renewable				0.0	0.7	1.0	1.5
Wood	0.1	0.0	0.0	0.0	0.0		
Waste/Biogas	-0.2	-0.1	-0.1	0.1	0.2	0.2	0.2
T&D networks	0.5	0.7	0.7	0.7	0.7	0.9	0.9
Import/Export	-0.1	-0.4	-0.6	-0.7	-0.9	-0.7	-0.6
Total	3.4	3.3	3.6	4.1	5.3	7.3	7.4

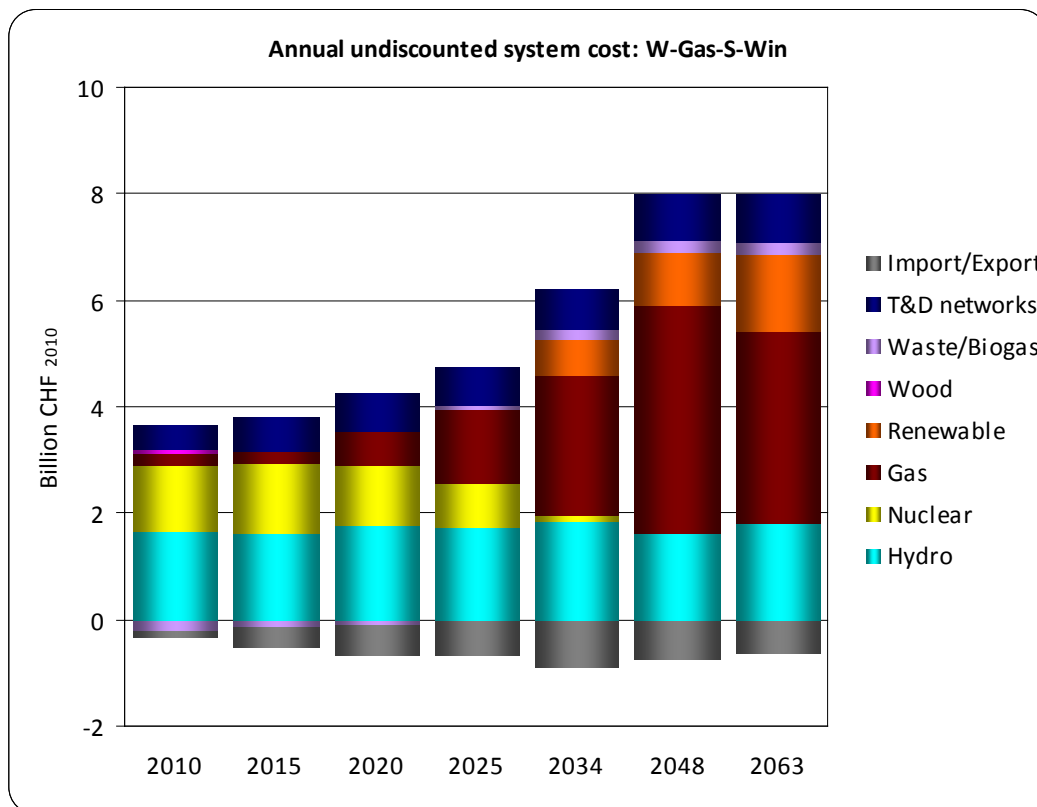


Fig. A-XV-102: Annual undiscounted system cost by technology category – *W-Gas-S*

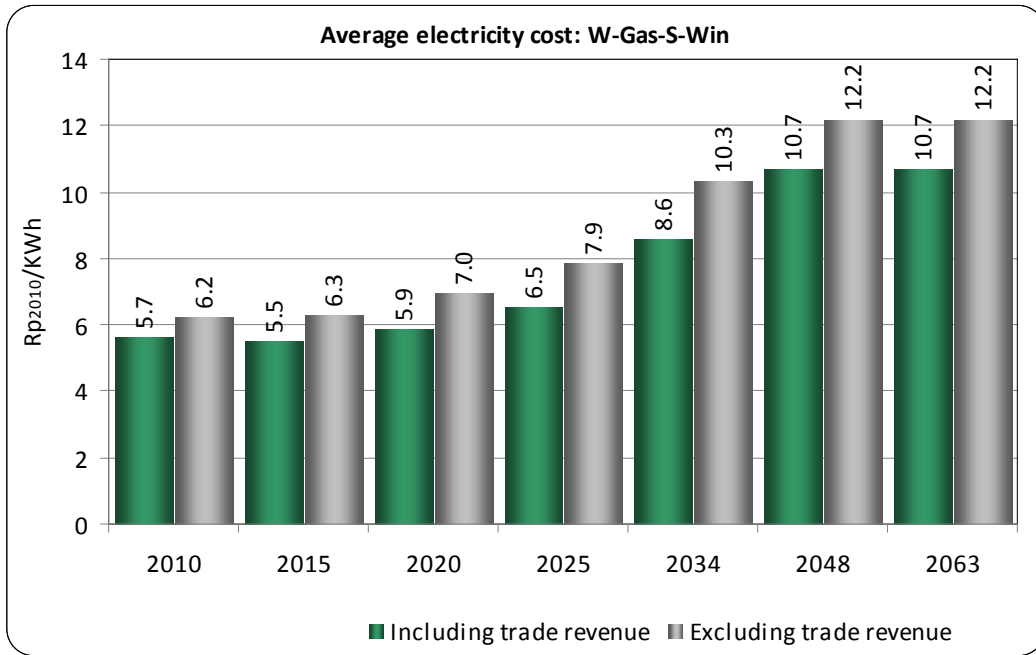


Fig. A-XV-103: Average cost of electricity – W-Gas-S

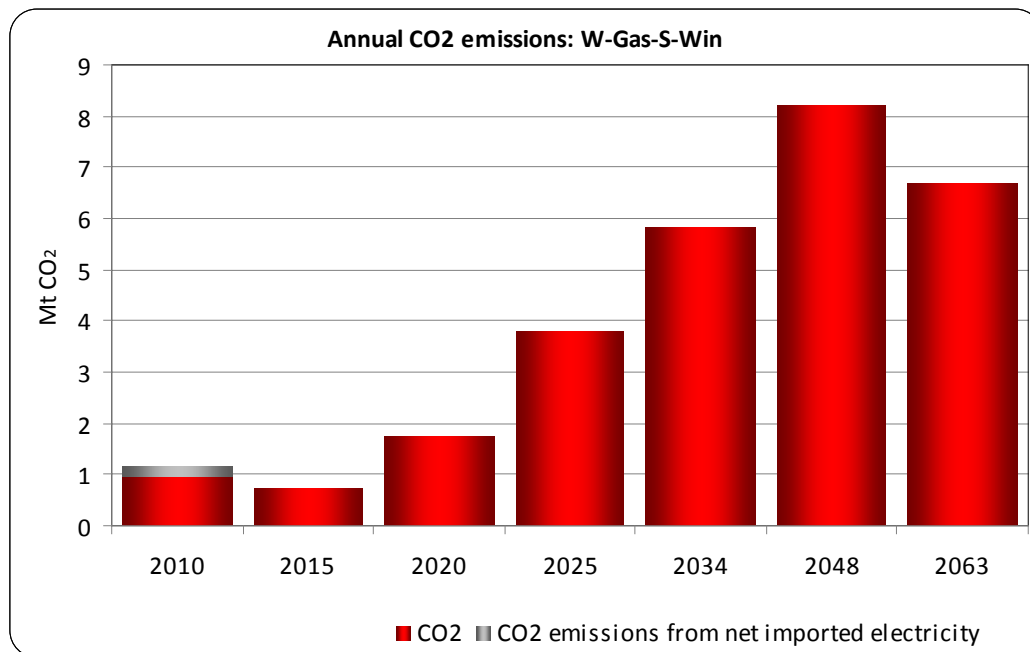


Fig. A-XV-104: Annual CO₂ emissions – W-Gas-S

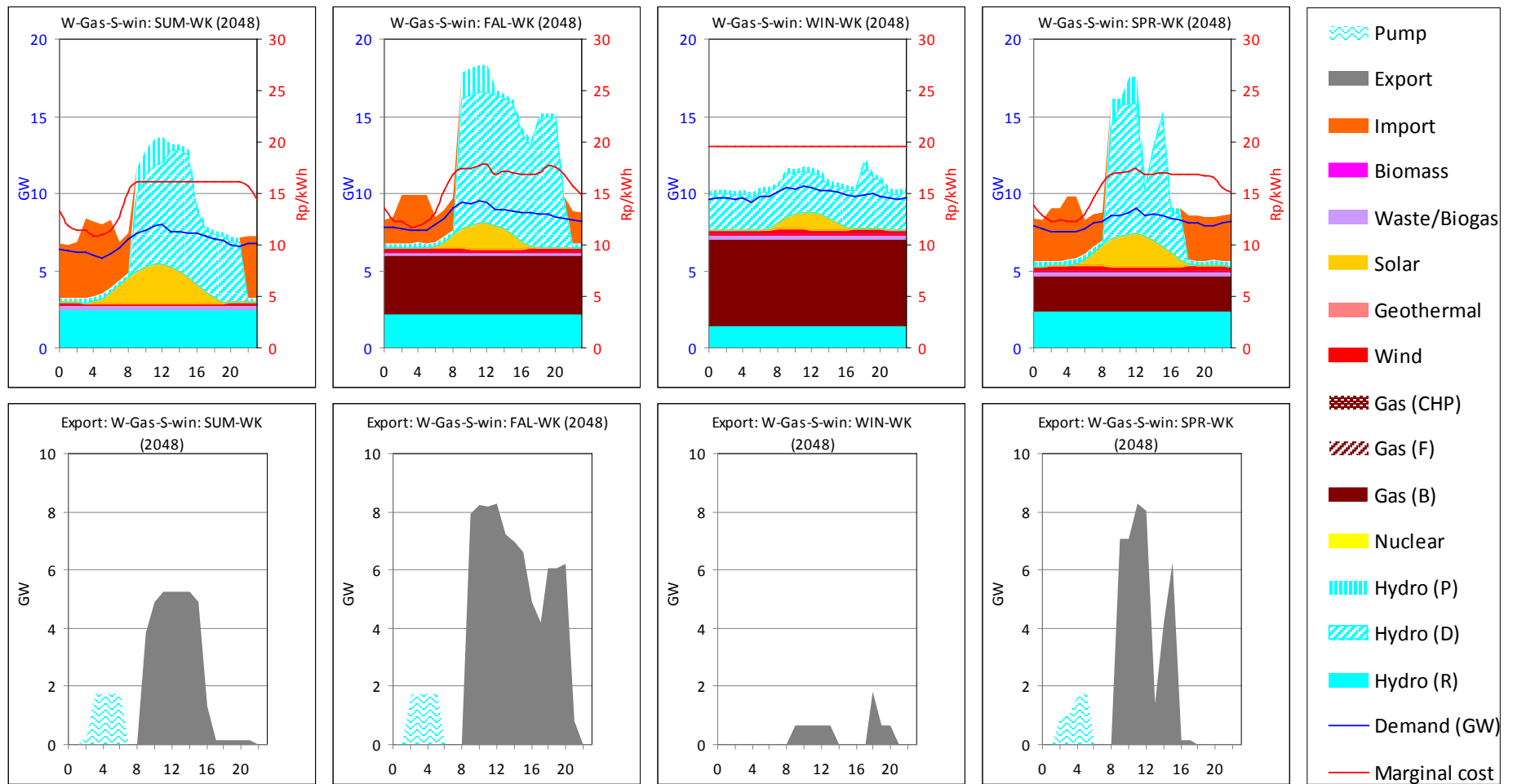


Fig. A-XV-105: Electricity generation schedule on weekdays – W-Gas-S

