EPFL

ME-409
2024/2025

Intermediate Report Feedback

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25th of November 2024

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Outline

1. General feedback

- Good reports overall, showing a proper understanding of the aim of the project (median: 5.25)
- Personal feedbacks will be uploaded on moodle soon
- The TAs remain available to answer questions and discuss some of the remarks

Scientific writing : Summary of how to write a scientific report at the end of project description

- **Methodology** : Mention all changes brought to the model and support them with hypotheses and/or references
- **Results discussion** : Describe the results and *don't forget to interpret them* !
- **Proofreading** : Proofread the report before submitting (typos, repetitions, contradictions)
- **General comments:** Be careful about energy types, carbon-neutrality, CCS vs DAC, resources and technologies
- **Figures/plots** : Should be as informative as possible with proper labels, legends and captions

2. Scientific writing

Classical report structure: abstract, introduction, methodology, results, discussion, conclusion

- Contextualize your work with an **introduction** ← (Perfect place to describe the 2022 system!)
- The **methodology** should present your model, support the changes you have made and the methodological tool you will use throughout your report
- Every presented **result** (table or graph) should be accompanied by a relevant observation (= description)
- **Discuss** the obtained results (= interpretation, in-depth analysis)
- A **conclusion** with strong arguments and take home messages provides the true value of a report

→ Make sure you (re)read what you have written, many of you sounded very GPT-like: vague, not concise, repetitive

To do's and not to do's

- Avoid the following style in scientific reports
  - First or second-person pronouns (I, our, we, you)
  - Future tense or past tense (will, then we did)
  - Exclamation marks (!), short versions (isn't → is not), ellipsis ("...")
  - Non-useful information: "we uploaded a csv", "we used an online platform"
  - Words such as "must", "could", "should"
  - Print every figures : 63124.34857 MCHF/y
- Every figure needs a clear caption, labeled axes, and a legend. The reader has to understand the figure without having to read the text. Whole sentences are allowed in the caption.
- Introduce abbreviations, nomenclature, and names.
- Appendices contain additional information, and are not necessary to understand your work. But putting there your main results makes no sense.
- Cite all sources for your values and statements, and include a bibliography at the end.

Writing style

✗

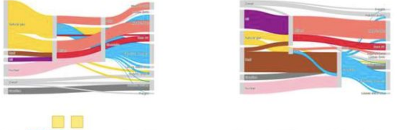
- We are showing on these two graphics above
- We observe that Switzerland has the lowest (!) energy-related CO2 emission
- We find that
- Use the Excel interface to run the model on the online platform...

✓

- Figures 2(a) and 2(b) show
- Switzerland has the lowest energy-related CO2 emission
- This result leads to the conclusion
- The model can either optimize the total annual costs [MCHF/year] or the global warming potential of operation (GWP) [ktCO2-eq/year] of the Swiss energy system.

Figures quality

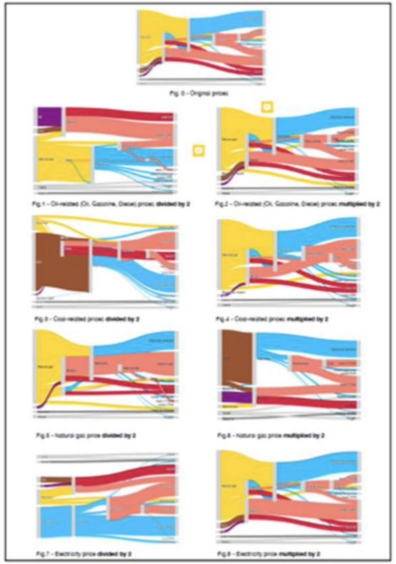
Too small figures



(a) Oil prize 0.06, natural gas prize 0.04. (b) Oil prize 0.04, natural gas prize 0.06.

Figure 4: TOTEX Minimization with different oil and gas prices [CHF/kWh].

Many figures displayed all at the same time



Screenshot without proper formatting (captions in another language are kept)

Tab. 4 Energiebilanz der Schweiz für das Jahr 2022 (in TJ)
Bilan énergétique de la Suisse pour 2022 (en TJ)

		Holzenergie / Energie du bois (1)	Kohle / Charbon (2)	Müll und Industrieabfälle / Ord. mén. et déchets ind. (3)	Rohöl / Pétrole brut (4)	Erdölprodukte / Produits pétroliers (5)	Gas / Gaz (6)	Wasserkraft / Energie hydraulique (7)	Kernbrennstoffe / Combustibles nucléaires (8)	Übrige erneuerbare Energien / Autres énergies renouvelables (9)	Elektrizität / Electricité (10)	Fernwärme / Chaleur à distance (11)	Total (12)	
Inlandproduktion	(a)	45 430	–	58 540	0	–	–	120 600	–	44 650	–	–	269 220	Production indigène
+ Import	(b)	2 390	3 870	–	133 310	246 440	106 720	–	252 140	6 270	119 220	–	870 360	+ Importation
+ Export	(c)	–110	–	–	0	–25 170	–	–	–	–	–107 040	–	–132 320	+ Exportation
+ Lagerveränderung[1]	(d)	–	–20	–	–600	18 740	–	–	–	–	–	–	18 120	+ Variation de stock[1]
= Bruttoverbrauch	(e)	47 710	3 850	58 540	132 710	240 010	106 720	120 600	252 140	50 920	12 180	–	1 025 380	= Consommation brute
+ Energieumwandlung:														+ Transformation d'énergie:
· Wasserkraftwerke	(f)	–	–	–	–	–	–	–120 600	–	–	120 600	–	0	· Centrales hydrauliques
· Kernkraftwerke	(g)	–	–	–	–	–	–	–	–252 140	–	83 210	1 390	–167 540	· Centrales nucléaires
· konventionell-thermische Kraft-, Fernheiz- und Fernheizkraftwerke	(h)	–3 720	0	–46 260	–	–420	–6 460	–	–	–	7 060	22 320	–27 480	· Centrales thermiques class., chauffage à distance, centrales chaleur-force
· Gaswerke	(i)	–	–	–	–	–	0	–	–	–	–	–	0	· Usines à gaz
· Raffinerien	(j)	–	–	–	–132 710	132 710	–	–	–	–	–	–	0	· Raffineries
· Diverse Erneuerbare	(k)	–2 720	–	–	–	–	1 520	–	–	–18 660	17 740	–	–2 120	· Renouvelables div.
+ Eigenverbrauch des Energiesektors, Netzverluste, Verbrauch der Speicherungen	(l)	–	–	–	–	–6 320	–130	–	–	–	–35 480	–2 350	–44 280	+ Consommation propre du secteur énergétique, pertes de réseau, pompage d'accumulation
+ Nichtenergetischer Verbrauch	(m)	–	–	–	–	–18 890	–	–	–	–	–	–	–18 890	+ Consommation non énergétique
= Endverbrauch	(n)	41 270	3 850	12 280	–	347 090	101 650	–	–	32 260	205 310	21 360	765 070	= Consommation finale
Haushalte	(o)	17 140	50	–	–	51 320	45 550	–	–	19 050	69 680	8 520	211 310	Ménages
Industrie	(p)	12 920	3 800	12 010	–	11 610	33 100	–	–	2 030	62 310	7 770	145 550	Industrie
Dienstleistungen	(q)	10 230	0	270	–	25 730	20 250	–	–	3 920	57 040	5 070	122 510	Services
Verkehr	(r)	–	–	–	–	256 310	920	–	–	6 730	12 850	–	276 810	Transport
Statistische Differenz inkl. Landwirtschaft	(s)	980	0	0	–	2 120	1 830	–	–	530	3 430	0	8 890	Différence statistique, y compris l'agriculture

[1] + Lagerabnahme
– Lagerzunahme

[1] + diminution de stock
– augmentation de stock

BFE, Schweizerische Gesamtenergiestatistik 2022 (Tab. 4)
OFEN, Statistique globale suisse de l'énergie 2022 (tabl. 4)

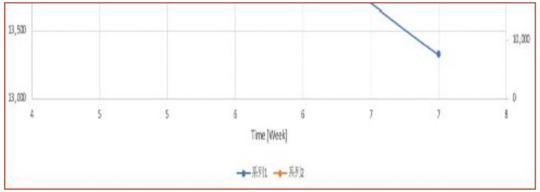
Usage of captions

No caption

The obtained Sankey diagram allows us to understand all the energy transfers taking place in Switzerland at our specific analysed time. The diagram once again shows that Nuclear

Natural gas	3010	ktoe	11.6%
Biofuels and	2373	ktoe	9.2%
Coal	148	ktoe	0.6%
Wind, solar, e	46	ktoe	0.2%
Sum	25919	ktoe	100.0%

progress in various energy conversion technologies will ow the strategies can be adjusted. Different energy to the model, step by step. The aim will be to minimize



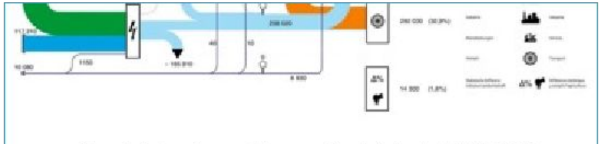


Figure 1: Sankey diagram of the energy flow in Switzerland, 2006, OFEN

	World TES	GWP optimized	Cost optimized
Nuclear	4.9%	39%	32%
Natural gas	22.8%	33%	47%
Oil	31.6%	7%	3%
Coal	26.9%	0%	5%

Table 1: Total Energy Supply (TES) by source, comparison between world trends and our scenarios for optimized GWP and cost

+ insert reference

	World	Switzerland
Total [Mtoe]	13 972	23.2
Coal share [%]	27.1	0.5
Oil share [%]	32.0	38.2
NG share [%]	22.2	13.0
Nuclear [%]	4.9	23.0
Hydro [%]	2.5	12.6
Biofuels and waste[%]	9.5	11.8
Others [%]	1.8	0.9

Table 2: Data of 2017: primary energy consumption [2]

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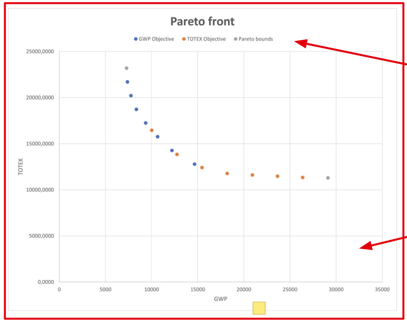
Presentation of plots

No caption, missing labelled axes and units



Font too small

Useless space

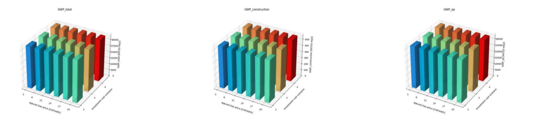
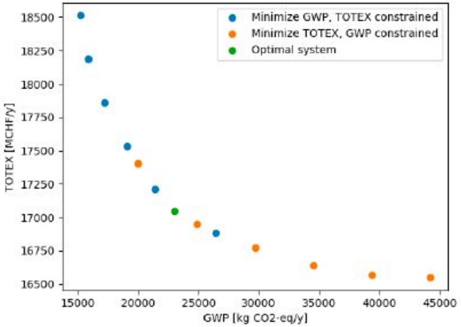
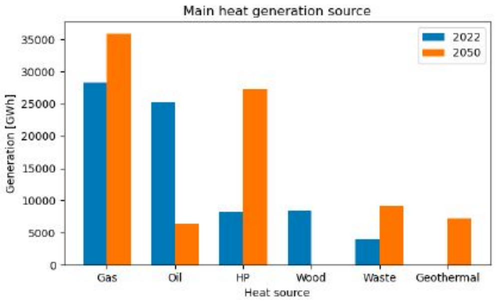


Figure 2: Environmental impact variations for TOTEX as objective function, for GWP (left), GWPcons (center) and GWPop (right) indicators.

Providing useless information





Usage of references

Reference put in the middle of the text

Source: "IEA: Key world energy statistics 2017". Data from sankey diagram converted from TWh to Mtoe (1 TWh = 0.086 Mtoe)

Copy paste of the section header

2.2 How are the emissions and the total primary energy consumption compared to the rest of the world

In this section we will mainly compare the proportion of the different energy used in Switzerland compared to the rest of the world.

Copy paste of the project description

Energy system in this milestone:
Presentation of the current energy system
Present the energy system you have up to this milestone, which should be the basic, non-renewable energy scenario of Switzerland. Explain the Sankey diagram - how is Switzerland covering the energy demand?

Sankey diagram:

References

[1] Office fédéral de l'énergie. *Statistique globale Suisse de l'énergie 2019.* https://www.bfe.admin.ch/bfe/fr/home/approvisionnement/statistiques-et-geodonnees/statistiques-de-lenergie/statistique-globale-de-l-energie.html. (Visited on the 28th of October 2020), pp. 41.

[2] International Energy Agency. *Key World Energy Statistics 2019.* https://www.iea.org/data-and-statistics?country=WORLD&fuel=Energy%20supply&indicator=TPESbySource1. 2019.

[3] Swissinfo. *Switzerland continues to bet on geothermal energy.* https://www.swissinfo.ch/eng/switzerland-continues-to-bet-on-geothermal-energy/45980810. 2020.

[4] Federal Statistic Office. *Heating system and energy sources.* https://www.bfs.admin.ch/bfs/en/home/statistics/construction-housing/buildings/energy-field.html. 2018.

Rigorous plan to present results

Contents

Simulation vs optimization

This is not the simulation, but the **optimization** of a model.

> **1. Simulation Results**
> Use the basic way to run the model under the initial technical condition
> nology. Figure 3 (a)~(b) are obtai

> The present Swiss energy system is composed only of non-renewable energy resources. Two simulations were performed. The first one aims to optimize the cost and the second one the global warming potential (GWP). Globally, the major transfers occur from nuclear to electricity and natural gas to heating systems.

- Energy system model = equations and parameters used to capture the behavior of an energy system.

- Optimization : the degree of freedom corresponds to the number of decision variables. It computes the best possible energy system which is fulfilling a particular objective (= minimization of the objective function).
  - Input : model with a specified range for the decision variables (e.g. f_{DHN} has to lie within [$f_{min\ DHN}$, $f_{max\ DHN}$])
  - Output : decision variables achieving the minimum objective

- Simulation = no degree of freedom.
  - Input : model with all its parameters fixed (no decision variable)
  - Output : any intermediate value that can be computed from the model (fully determined by its equations and parameters)

3. Methodology and hypotheses

- Describe your starting situation: briefly mention the model and what it represents
- Present the change you have made to the default parameters and how you got them:
    - Demands for 2050
    - Minimum installed capacity
    - Any other fine-tuning you decided to do
- The chosen values for the parameters should be supported by either:
    - An external source (paper, open database, public institution)
    - A finding resulting form your own calculations (if so, briefly expose them)

4. Results *description* vs Results *discussion*

- **Results description**

Results description is a concise presentation of the raw data or findings obtained from an experiment or research study, typically in a factual and straightforward manner. It involves reporting the observed values, measurements, or outcomes without interpretation or analysis.

- **Results discussion**

Results discussion is an interpretive and analytical section of a scientific report or research paper that goes beyond the presentation of raw data. It involves an in-depth analysis, explanation, and interpretation of the results, often discussing the significance, implications, and potential applications of the findings.

Tips for your reporting

Results description

- In addition to absolute values, it is nice to use relative metrics (% in share, % variation)

Results discussion

- Good to have a feeling of magnitude:
  - 1 GW capacity ? What share of my electricity demand does it represent ?
  - 5000 ktCO2-eq/year reduction, is it a significant variation compared to my previous scenario ?
  - What are the reasons for the importance of such coal in my mix ? What is my objective ? What are the emissions and the costs of coal regarding other resources ?
- Make comparison by confronting your results with studies from others and with reality
  - Today what is the share of heat pump in the actual Swiss energy system ?
  - Today what is the share of electric vehicles into private mobility ? Or the share of hydrogen into public mobility ?
- Draw conclusions from it and do not ignore the unexpected results, but rather highlight them

Example with solar panel technologies

Let's say we conducted an experiment to compare the energy efficiency of two different solar panel technologies:

Results description

"In our experiment, we tested two types of solar panels: Monocrystalline and Polycrystalline. We found that the Monocrystalline panels had a higher energy conversion efficiency of 18%, while the Polycrystalline panels had an efficiency of 15%. This demonstrates that Monocrystalline panels are more efficient in converting sunlight into electricity."

Results discussion

"The observed difference in energy conversion efficiency between Monocrystalline and Polycrystalline solar panels is a significant finding with important implications for the design and implementation of solar energy systems. The higher efficiency of Monocrystalline panels means that they can generate more electricity per unit area compared to Polycrystalline panels.

This result has practical implications for the installation of solar panels in real-world applications. For instance, in locations where space is limited, such as urban environments, Monocrystalline panels may be a more attractive option, as they can generate more power from the available area. Conversely, in regions with ample space and lower cost considerations, Polycrystalline panels might still be a viable choice.

Moreover, considering the economic aspect, Monocrystalline panels, despite their higher efficiency, tend to be more expensive to manufacture. The decision to use Monocrystalline or Polycrystalline panels should consider a balance between the initial cost of the panels and the long-term energy generation benefits. Factors like location, available space, and budget constraints need to be taken into account when designing efficient and cost-effective solar energy systems."

Example with wind turbine blade design

Let's say we conducted an experiment to compare the energy efficiency of two different wind turbine blade designs:

Results description

"In our study, we investigated the impact of wind turbine blade design on energy production. We tested two blade designs: a traditional flat-blade design and an innovative curved-blade design. Over the course of a year, we monitored the energy output from both wind turbines. The traditional flat-blade design generated an average of 500 kilowatt-hours (kWh) per month, while the innovative curved-blade design produced an average of 600 kWh per month. This indicates that the curved-blade design outperforms the flat-blade design in terms of electricity production."

Results discussion

"The increase in energy production observed with the curved-blade design is a noteworthy finding, suggesting that the shape of wind turbine blades can have a substantial impact on energy generation. This result has practical implications for the design of wind turbines in the renewable energy sector.

The curved-blade design, with its higher energy production, is a promising development for wind energy systems. It may be particularly beneficial in regions with lower average wind speeds, as it maximizes energy capture under such conditions. Additionally, the improved performance of the curved-blade design could lead to a reduction in the number of turbines required for a given energy production target, which can translate into cost savings and a smaller environmental footprint.

However, it's essential to consider factors beyond energy production, such as manufacturing costs, maintenance, and environmental sustainability when adopting the curved-blade design on a larger scale. This may require further research and development efforts."

5. Towards Final Report

Final report contains :

- Intermediate Report (updated results if necessary)
- + **Additional** scenario (literature review, Pareto front, analysis)
- + Perform a **sensitivity analysis** for given parameters.

Questions are always welcome:

- Use first and foremost the project session
- You may also use the Ed forum, the answer to your question there will benefit to everyone