

DESIGN PROJECT 2025

TERRITORIAL ANALYSIS MUNICIPALITIES

EPFL professor: Michael Lehning External supervisor: Loli Chambrey

Objectives

- Identify and quantify the renewable energy sources on the territory of each Swiss municipality
- Compiling the existing Navitas database with the renewable energy potential and demographic data of the municipalities
- Classify Swiss municipalities according to various characteristics related to energy planning, in order to establish guidelines for energy transition

Results

Comparison of the estimated potential values for each renewable energy source to values found in scientific literature and the actual amount of energy produced (in GWh/y):

Source	Estimated (GWh/y)	Literature (GWh/y)	Produced (GWh/y)
Solar	118,000	24,000	1,900
Hydro	43,000	49,000	35,000
Wind	20,000	45,000	140
Geothermal energy	2,000	1,000	1,000
Biomass	2,000	1,000	1,000
WWTPs	2,000	1,000	1,000

Across the 6 listed sources, the estimated potential far exceeds actual production.

- Hydroelectricity and biomass energy show comparatively smaller disparities
- Solar energy, geothermal energy, and heat from WWTPs significantly underutilized
- Wind energy production represents less than 1% of its potential, and despite its high potential, hydrothermal energy remains untapped

RECOGNITION AND PREDICTION OF MILDW AND OIDIUM

INTRODUCTION

Context: Vine cultures have been increasingly targeted by Oidium and Mildew fungi with the intensification of viticulture on Swiss lands. Their importance for the treatment of these two diseases is of great economic importance for wine growers. One axis of improvement is the forecasting of outbreaks and spreading of these diseases.

Objectives: To assess the project consists in the implementation of two models. The first one is training at classifying pictures of leaves as either Healthy or diseased by Mildew or Oidium. These results can then be used as training set for a second model which is forecasting outbreaks and the evolution of the diseases, based on meteorological data.

MODELS

METHODOLOGY (CLASSIFICATION)

Images of vine leaves are used to train different models.

Other variations [Off/On]

- Background removal
- Weighting the loss
- Fine tuning (last layer only)

METHODOLOGY (FORECASTING)

Dataset The Forecasting dataset is made of Epidemiological samples:

- Oidium : 40 samples
- Mildew: 120 samples (additional dataset)

Training Epidemiological curves are generated from the leaves (one sample per day) and two models are trained on those curves.

Technics

- Feature augmentation (previous days)
- Active learning (pseudo-labeling)
- Grid-search for hyperparameters optimization

RESULTS (CLASSIFICATION)

Best Model	Choice
Parameter	ResNet50
Background removal	No
Weights	No

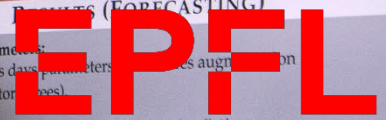
RESULTS (FORECASTING)

Best hyper-parameters:

- 14 previous days parameters
- 100 estimator (trees)

Mildew - Label vs Predictions

Meeting: 26 November 2024
 Pierre-Yves Gilliéron, SIE Deputy Head
 Christina Treier, SIE Administrator



Agenda

- Goals
- Skills
- Cycle of the design
- Work Organization
- Agreement, Budget
- Starting the DP
- Report & Presentation
- Important Dates



Source: <http://datadrivenaid.org>

Context and Goals

- The goal of the Design Project is to put your knowledge in practice within the **context of professional work**
- A team of students will be working as a consultancy company
 - **Customer:** company, administration
 - **Mandate:** context, objectives, problem to be solved, expectations
 - **Salary:** evaluation of your work (grade, ECTS); learning outcomes
 - **Responsibility:** project management (meetings); searching for information/data; communication; deadlines

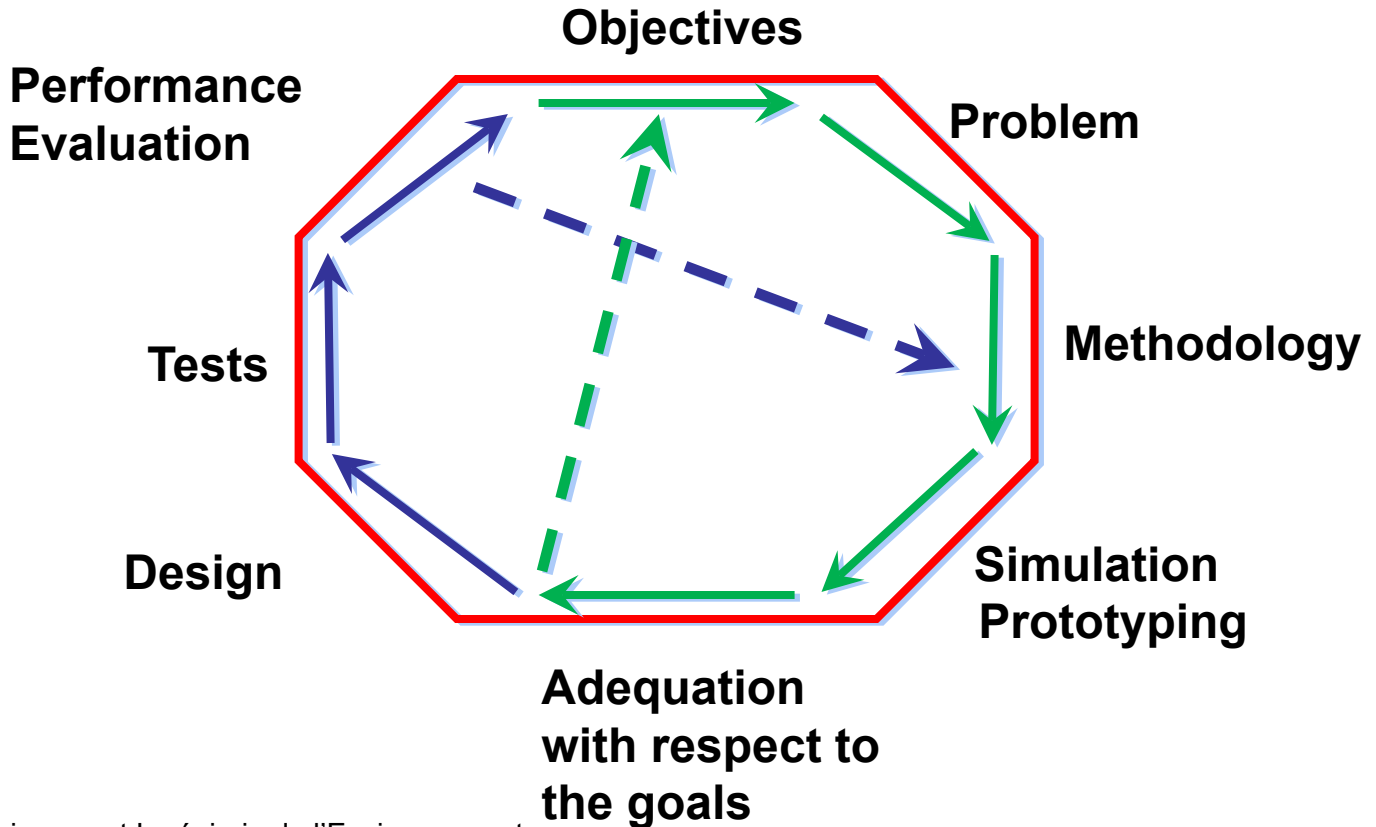
Overall Skills

- **Using your knowledge** in basic sciences and engineering within the context of a real project
- **Understanding** of a problem
- **Defining** the needs
- **Developing** a methodology
- **Designing** scenarios
- **Leading** a project and assessing solutions
- **Working** in a team

Specific & Transversal Skills

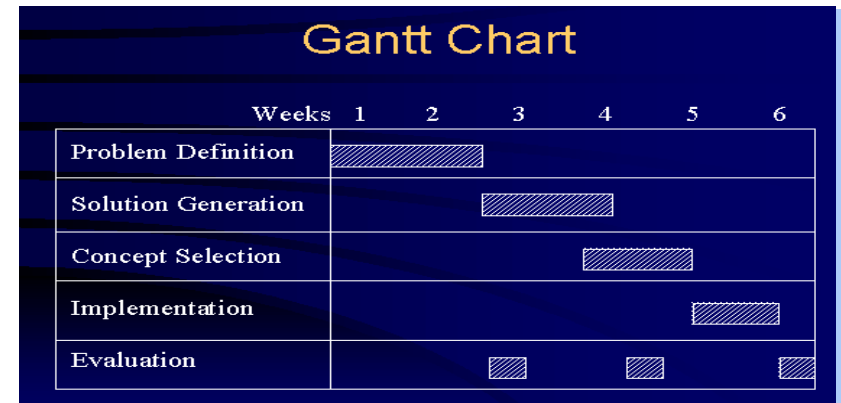
- **To identify, to express and to solve** an engineering issue
 - Defining the project and writing a detailed proposal
 - Analyzing the different and potential options
 - Choosing the best option according to technical constraints and several characteristics
 - Solving a practical engineering issue
- **To manage** the different steps of the projects
- **To communicate** in an efficient way: proposal, report, oral presentation
- **To work in team and with a partner**

Cycle of the Design



Main Milestones of DP

- Identification of the topic and clarification of the problem to be solved
- Organization of the DP
 - Meetings, project proposal, definition of the tasks & planning
- **The project proposal must be approved by the partner and by EPFL**
- Main tasks
 - Work approach, methodology
 - Collect basic data and information
 - Bibliography and references
 - Development of scenarios/options
 - Presentation of selected options
 - Development of a prototype
 - Solutions assessment
- Communication of outcomes



Work Organization

- DP: Master MA2; Bloc 1; 10 ECTS
- Work load ~ **2 days/week**
 - 10 ECTS = **250-300 hours x 2 students**
- Working in a team
 - Timeline, description of the tasks
 - Sharing the tasks
 - Distributing the work load during the semester
 - Realistic work flow



Week Organization (W#)

- W1: Kick-off meeting; Partner-Academic supervisor-You
- W2: Signature of the agreement and budget
- W3: Project proposal (3 pages, 10% of the grade)
- W9: Mid-term report, technical paper (4-6 pages, 15%)
- W13: Draft final report for review, setup of poster
- W14: Poster session & Final event
- W15: Final report (50%)
- Oral presentation (25%)

Agreement

- Elements of the agreement
 - Bilateral responsibilities
 - Topic
 - Names of parties
 - Signatures
 - Company representative
 - Academic supervisor
 - Students

Section Sciences et Ingénierie de l'Environnement
Master M2 – semestre de printemps 2018
Design project
EPFL

1. Titre du projet :

2. Étudiants : 1.
2.

3. Encadrant EPFL
Tél.
Tél.

4. Encadrant externe
Tél.
e-mail :

5. Description du projet

6. Accord
Toutes les parties impliquées dans ce projet, les étudiants et les encadrants, se sont mises d'accord sur les objectifs du design project décrits ci-dessus. Les étudiants et les encadrants s'engagent à mener au mieux le projet avec des contacts réguliers par téléphone, e-mail et des réunions. Un budget pour les différents frais du projet (déplacements, consommables, autres) va être établi et soumis à la section dans la semaine 3 (jusqu'au vendredi 9 mars 2018). La section va ensuite déterminer quelle somme de ces frais elle peut rémunérer.

Lieu et date :

signature encadrant EPFL
signature étudiant 1
signature encadrant externe
signature étudiant 2

Budget and Financial aspects

- Budget

- Participation of the SIE Section to the costs
 - Travel
 - Some lab analysis
 - Various costs (small equipment)
- Week 2: Submission of the Budget to the SIE Section (e-mail to christina.treier@epfl.ch)

- Reimbursement of expenses (at the end of the DP)

- Financial responsibility (one student/group)

- Keeping accurate accounts
- Record all the receipts, bills (original documents)
- To inform the SIE Office (Ch. Treier) in case of budget overrun


Travel

- **Use the public transportation:** keep your receipts/tickets for the reimbursement. No reimbursement for students who have a travel pass (ex. abonnement général)
- Possibility to book a car with Mobility car sharing
 - <https://www.epfl.ch/campus/mobility/vehicles/mobility-carsharing/>
 - Contact christina.treier@epfl.ch for booking

Varia

- **Responsibility for equipment**
 - In case of loss, theft and damage
 - Replacement is under the responsibility of the students
 - Use of your own insurance (theft, civil liability)
- **Phone**
 - No reimbursement of telecommunication expenses
Use the softphone and/or videoconference applications
- **Printing**
 - Final report: 20.- /printed bound report; add in the budget
 - Number of copies to be defined with external partner
 - Poster: 10.-/A0 copy; use the ENAC printing service
More information will follow in due time

Starting the DP [SIE; students]

Collect of proposals and evaluation List of topics on SIE web pages	~November 2024 10th December 2024	
Building groups of 2 students (preferably combine international with french speaking students) Choice and repartition of the topics	From 10th Dec. 24 until 8th January 2025 Under the responsibility of students (one contact person for the Section)	
Final choice and communication to partners & professors	Mid-January 2025	
Preliminary contacts with external partner and academic supervisor	From January and before the beginning of the Spring semester	
Kick-off Meeting	Friday 21st February 2025 (or another day during the week)	

Report and Presentation

- **Final Report**
 - Draft version for a review by partner and academic supervisor
 - ~15 pages + Annexes
 - Final version: to be submitted one week after the end of the semester
- **Oral Presentation**
 - 12-16 slides
 - Duration: 20 min (incl. discussion)
 - Scheduled by all parties; after the end of the semester
 - Individual organization by project
- **Poster**
 - Directives and templates provided by SIE Section
 - Public poster session: beginning of June 2025, afternoon; incl. Apéro

Poster

Quantification of Discharges and Mapping of Surface Runoff in the Jura

Students: Armelle Bouhali, Rafik Tewfik

Company: ATB, John Beck
EPFL supervisor: Sara Bonetti

Context

- Surface runoff caused significant damage in the Jura and Jura-Semolis during the summer of 2021.
- The surface runoffs were generated by storms occurring on already saturated soils.
- The frequency of such non-fluvial flood events is predicted to increase due to climate change.



Objectives

Develop simulations of the runoff in each watershed using two software (HEC-RAS and PC SWMM).

Case studies

- Courvaire (JU) → 10/07/2021, La Combalte and La Combe watersheds.
- Corgémont (BE) → 22/06/2021, North watershed.

Methodology

1. Topography and buildings

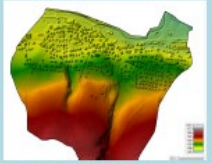


Fig. 1: Topographic data obtained from Surface3d from the Federal Office of Topography). Terrain points and building points are merged into a unified Digital Terrain Model (DTM).

HEC-RAS uses the building block method to incorporate buildings, elevating blocks from ground level to rooftop height. PC SWMM uses the building hole method, representing buildings as holes in the computational grid.

Rainfall spatial variability is significant during storms, so the rainfall data is increased accordingly compared to the data recorded in the station.

2. Precipitation

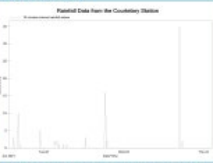


Fig. 2: Precipitation data is sourced from nearby Meteoguisse station.

3. Infiltration

The SCS (Soil Conservation Service) method is used to parameterize infiltration. Each sub-catchment is assigned a curve number based on soil and land cover data. A higher curve number represents a surface that generates more runoff.

4. Soil data

The acquisition of soil data, particularly pertaining to the designated areas, presents inherent difficulties and is not readily accessible. The availability of pertinent data obtained from the Federal Offices for the Environment (FOEN) remains limited.

5. Land cover and roughness data

Data comes from the local cadastral information for Corgémont, and a combination of Corine Satellite land cover data and Jura zoning information is used for Courvaire.

Results



Fig. 3: PC SWMM subcatchments of the La Combe catchment for Courvaire.



Fig. 4: Close up of the PC SWMM simulation for Courvaire (La Combe) showing maximum water height (m).

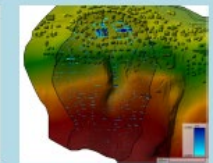


Fig. 5: HEC-RAS 2D simulation for Courvaire (La Combe) showing maximum water height (m).

Validation method

- Two methods are used to evaluate simulation accuracy:
- 1) Comparing the model with observed runoff data from summer 2021 to assess realism qualitatively.
 - 2) Comparing model-estimated discharge with hazard maps. Adjustments are made if the discharge significantly exceeds hazard map estimations.

Discussion

- PC-SWMM is found to be more user-friendly compared to HEC-RAS 2D.
- Field data is crucial for accurate surface runoff modeling, especially considering the impact of small fences/walls.
- The SCS method shows promise for parameterizing infiltration, but further analysis and comparison with alternative methods are needed.

Conclusion

The simulations of the events are mostly satisfying, and sensitive areas can be identified. However, field data is essential to further improve the simulation and enhance the correspondence of the model with the actual site. In order to obtain better water height values and accurately scale the runoff, soil data should be more effectively incorporated to enhance infiltration parameterization.

SYSTEMATIC TERRITORIAL ANALYSIS OF SWISS MUNICIPALITIES

Students: Lena Karth, Aneta Kerckovic

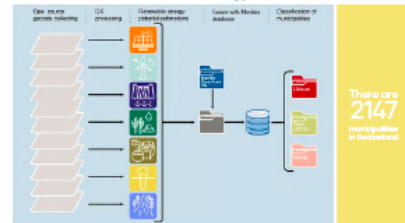
EPFL professor: Michael Lehning

External supervisor: Loïc Chambovey

Context

This project develops a systematic analysis of Swiss municipal territories to identify available energy sources and evaluate their theoretical potential. Municipality-level energy system transformation lacks a comprehensive strategy, therefore it is necessary to find patterns and group municipalities for which a similar strategy could be applied. The theoretical potential is not specific to local conditions and estimate using open source data on geography and demography making it the perfect candidate for the basis of such a classification.

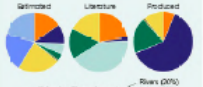
Methodology



Total extracted renewable energy potential (kWh/yr)



The distribution of estimated potentials in this study differs significantly from what is found in the literature and the actual energy production.



Estimated energy production (kWh/yr)



The total energy consumption in Switzerland was 794720 Tj (= 220755 GWh) in 2021.

Renewable energy production



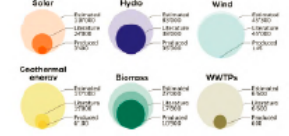
The final classification contains 19 classes based on municipality type (urban, suburban, rural) and main renewable energy source. Most classes contain 40 to 100 municipalities.

Objectives

1. Identify and quantify the renewable energy sources on the territory of each Swiss municipality.
2. Compiling the existing Navitas database with the renewable energy potential and demographic data of the municipalities.
3. Classify Swiss municipalities according to various characteristics related to energy planning. In order to establish guidelines for energy transition.

Results

Comparison of the estimated potential values for each renewable energy source to values found in scientific literature and the actual amount of energy produced (in GWh/yr):

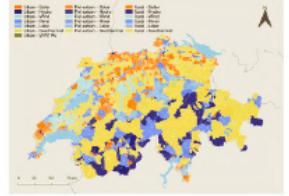


Across the 6 listed sources, the estimated potential far exceeds the actual production.

- Hydroelectricity and biomass energy show comparatively smaller disparities.
- Solar energy, geothermal energy, and heat from WWT/Pls are significantly underutilized.
- Wind energy production represents less than 1% of its potential, and despite its high potential, hydrothermal energy remains unexploited.

Comparing our estimations with the literature provides insights on methodology accuracy and identifies overestimations or realistic estimates for each energy source.

Classification by dominant energy and municipality type



Energy source distribution for each municipality type:



Legend

- Solar energy
- Hydropower
- Wind energy
- Energy from biomass
- Heat recovery from WWT/Pls
- Geothermal energy
- Heat extraction from lakes
- Heat extraction from rivers

DP - Important Dates

- **Friday 21st February 2025:** 1st meeting between the 3 parties (students, partner and SIE Professor)
- **Thursday 27th February 2025** (12h-13h – room TBD): permanence office hour on the information sources, and literature search, by Myriam Petrilli, Teaching Librarian
- **Friday 28th February 2025:** submission of the signed contract and budget estimation to the Section
- **Friday 7th March 2025:** submission of the goals, expectations and calendar to the SIE Professor and external partner
- **Thursday 17th April 2025:** submission of intermediate report to the SIE Professor and external partner
- **Wednesday 21st May 2025:** deadline for sending the PDF version of report to the SIE Professor and external partner for comments before finalization
- **Monday 2nd June 2025**, between 13h00 and 17h00 : printing of A0 poster at SG 0215 office (ENAC-IT)
- **Beginning of June 2025:** **poster session of the Design Projects, from 14h to 17h, room TBD**
- **Friday 6th June 2025:** submission of the final report version (PDF) to the SIE Professor and partner
- **Between 2nd and 13th June 2025:** oral presentation of the Design Projects
- **Monday 14th July 2025:** submission of the grades to the SAC (by SIE Professors)

QUESTIONS



Web Page: [Design Project](#)

EPFL-Section des Sciences et Ingénierie de l'Environnement

EPFL

Complementary instructions for completing the Design Project

First of all, please have a look at the « [Instructions for the completion of the Design Project](#) » on our web site.

TRANSPORTATION

1. For your travels, please choose public transportation. Keep all your receipts for reimbursement. EPFL does not reimburse travels with the GA card (« Abonnement général »)
2. It is possible to rent a Mobility car from the Section: christina.treier@epfl.ch.

MEALS

3. No reimbursements for meals
4. Please contact us in case of a meal/meeting

PRINTING OF REPORTS

5. If paper printing is required, the Section allocates CHF 20.- per report, including binding, for a maximum of 4 reports per group. 1 copy per student and 1 copy per supervisor (please add the number of copies printed on your reimbursement sheet). Intermediate reports, other printing or supply costs are not reimbursed. The SIE Section does not need any printed report.

POSTER PRINTING

6. On Tuesday 3rd June 2025, the ENAC- IT team, [Nikita Duarte Montoya](#), will help you printing your Poster in room SG 0215, from 13h30 on.
7. There is one A0 Poster per group.
8. The costs are covered by the Section.
9. Printing instructions will be sent to you by e-mail by Nikita Duarte Montoya in due time.
10. **On Wednesday 4th June 2025 (afternoon) the Section organizes a Design Project Poster session.**
You will be required to fix your Posters on a Panel, on GR 3rd floor (GR A3 31, GR A2 32 and GR B3 30). Numbers on the panels will show you where to hang your Poster up (number on panel = number of Design Project). More instructions will follow in due time.

REIMBURSEMENT (once the Design Project is completed)

11. The EPFL Financial Department does not make any reimbursement without presentation of receipts. So please keep all of them.
12. Please send them to the Section (christina.treier@epfl.ch) including:
 - The reimbursement form, filled with your contact details and your IBAN number.
 - Your scanned receipts (clearly legible).
 - a copy of your passport or ID card
 - a copy of your RIB (Statement of bank identity), or copy of your credit card
 - please send only one reimbursement form per group

Deadline for sending your receipts: end of June 2025.