GreenFlow.ai

Increasing share of renewable energies for a smart trackable grid

Zoe Delaplace Compaore - zoe.compaore@skema.edu
Edmond de Maistre - edmond.demaistre@skema.edu
Lucas Meira Rolo - lucas.meirarolo@skema.edu
Rayane Wassim BABA ALI - rayanewassim.babaali@skema.edu
Théo Metzger - theo.metzger@skema.edu
Idriss Elatrech - idriss.elatrechkratima@skema.edu

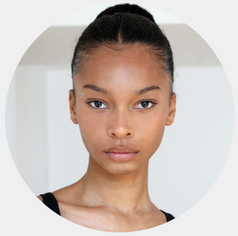
BUSINESS PLAN TEAM 2

a great team

idriss

Rayane

Edmond



Zoé

Lucas

Théo

backed by ENGIE

Global Energy Leader: 98,000 employees powering 30+ countries

Massive Portfolio: 107 GW capacity (51% renewables, 49% thermal)

Innovation Hub: 600+ R&I experts driving AI and green tech

Grid Expertise: 9,000 R&F GBU pros managing a resilient energy network

To Focus on Electricity Management in Production & Distribution

- Carbon Neutrality by 2045
- 95 GW of renewable and storage capacity by 2030
- Massive electrification & flexibility
- Be the best utility in the ernergy transition by 2030

Transforming energy waste into opportunity: GreenFlow drives ENGIE toward a carbon-neutral future by 2045

The Massive Problem: $100B*+ in Wasted Opportunity

Loss & Waste of Renewable Energy
*(5+% wasted yearly due to **battery** limits)*

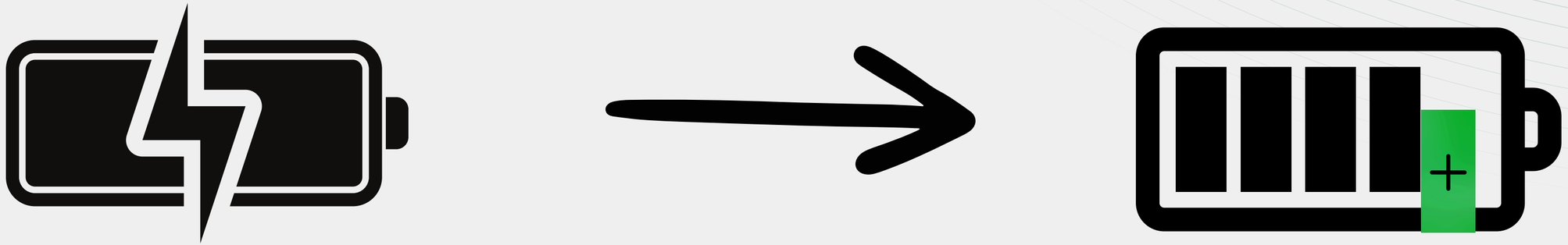
Over-reliance on Fossil Fuels
(49% of ENGIE's 107 GW portfolio)

Unplanned Outages and Grid Reliability
*(2-3 **outages**/10 GW, €1B+ in back-up costs)*

Inefficient Energy Dispatch

*Global Energy Perspective 2025, McKinsey & Company

Description of the solution



There is a loss when batteries are at 100% because if the weather allow it we may have produced renewable energies during that time. So how to optimize this situation in order to keep place for a maximized production of renewable energies ?

The goal of Greenflow is to forecast when renewable energy will be lost due to limited battery storage capacity.
By using two predictive models(One on production and one on consumption), Greenflow aims to anticipate these moments in advance and signal when batteries are expected to reach 100% capacity.

This allows energy producers to proactively reduce fossil fuel generation one or two days beforehand, ensuring there is enough storage space to capture and maximize renewable energy production whenever weather(predictive model 1) allow it and whenever we do not need the 100% of the battery immediately (predictive model 2)

An AI plateform Maximizing Renewables with Predictive AI

Predict

1

Predictive Forecasting

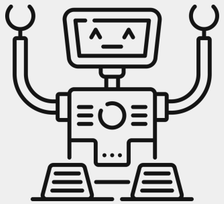
- Forecast renewable output using weather & historical data
- Predict demand spikes to avoid battery overflows
- Anticipate market trends for optimal energy sales

Optimize

2

Real-time Supervision

- Monitor SCADA/IoT feeds for instant anomaly detection
- Balance energy mix to cut fossil fuel use
- Adjust dispatch dynamically for renewable boost



Automate

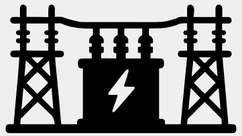
3

Automation with Human Oversight

- Automate smart dispatch for grid reliability
- Reduce outages with AI-driven decisions & alerts
- Ensure €M+ savings via efficient, scalable ops

Market Analysis

Existing & planned products



3 axes:

-Tracking precisely greenhouse gas emissions for companies

There doesn't seem to be a company in France that does precise real-time tracking and reporting services for companies. Engie is the closest one yet, which means even better if we can improve that service.

-Predicting Renewable energy production

EDF already uses forecasting to optimize dispatch of energy quantity.

-Predicting peaks in energy usage throughout the day

energy Pool: predict peaks, "High Penetration of renewables will require Demand Flexibility

Flexible consumers able to store energy could be an alternative to expensive electrochemical battery

Market segments

-Companies:

Engie can now sell its solution to big companies who have obligations towards the government in keeping their emissions under a certain threshold. It allows them to have full transparency and never-before see precision on their carbon emissions.

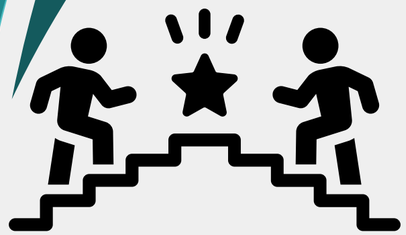
-**Regular clients:**

The cost of renewable energies is significantly lower than fossil fuels and nuclear energy. Therefore the average person has every reason to switch to the Engie solution to power its home.

-**Foreign markets:**

since Engie already has branches on other continents, including less developed countries, it would be a good switch to do early-on, in order to commodify renewable energies and allow poorer people to benefit from them too. third world countries often rely way too much on fossil fuels, causing degradation to the people's environment, simply because fossil fuel are the cheapest for them at the moment.

Market Analysis



Market players / competitors

Competitors:
EDF
Total Energies
Veolia
Siemens Energy
Iberdrola (Spain)
Enel (Italy)
E.ON (Germany)
RWE(Germany)
Shell Renewables & Shell Energy

Startups:
Neoen
Voltalia

Who loses if you win and what will be their responses?

If engie decides to internalize all those aspects and produce them itself, many smaller companies might see a decrease in their market share. Companies like Neoen, Voltalia, who have similar services do not have the reputation and power that Engie has. They might continue to offer services buyable by other companies, but it would be hard to compete with a giant like Engie.
However, Engie could decide to partner with those companies in order to reduce R&D costs. That would mean the data of the customers is shared. That way, there would be less losers among small french companies, but more among Engie's competitors like EDF or Total Energies in France, which would be a better thing ethically wise.

Key Data Sources

- **Operational Data –** *SCADA streams, IoT sensors, and real-time consumption logs from ENGIE's 102 GW portfolio.*

- **Weather & Environmental Data –** *Forecasts, climate patterns, and satellite imagery to predict renewable output.*

- **Market & Policy Data –** *Electricity prices, carbon pricing, and regulatory incentives guiding optimization.*

- **Historical & Aggregated Data –** *Past generation/consumption datasets and cross-utility benchmarks for training.*

- **Quality & Governance Data –** *Sensor reliability, ESG compliance, and grid stability metadata.*

Design & Development: Intelligent Energy Management System

- Anticipate renewable production (weather + AI)

- Optimize battery charge/discharge

- Enable demand response & reduce CO_2

Design & Development: Intelligent Energy Management System

🤝 Data Acquisition / Partnerships

GreenFlow can be fed in two ways.

1- Option A (Open-source weather APIs) such as OpenWeatherMap lets us launch a pilot fast and at low cost. It’s perfect for proving value and iterating quickly, but the spatial/temporal resolution and service guarantees are limited, so accuracy can fluctuate on complex micro-climates.

2- Option B (Professional data via partnership, e.g., Météo-France) provides higher-resolution forecasts, richer parameters (irradiance, multi-height wind, cloud cover), SLAs, and support ideal for industrial rollout and critical sites.

STEPS TO IMPLEMENT THE SOLUTION

Data Collection

- Weather data (APIs: WeatherAPI / Pro services: Météo France)
- Key variables: solar irradiance, wind speed, temperature, humidity
- User consumption (Engie smart meters)

Storage & Preprocessing

- Centralized time-series DB (PostgreSQL, InfluxDB)
- Cleaning & handling missing values
- Normalization & scaling for AI models

Predictive AI

- Forecast renewable production & demand
- Models: LSTM, ARIMA, XGBoost
- Inputs: predicted weather + historical consumption

Battery Control Logic

- AI forecasts help anticipate charging/discharging

impact of solution on business & environment

POSITIVE IMPACTS

Engie will develop new tools and strategies in order to maximize the share of renewables in the mix → they may then sell their solution and it might become the standard for electricity distribution companies

Engie would be a pioneer in terms of real-time tracking and reporting of greenhouse gas emissions for client companies. This would set them a high share of the market if they can achieve it.

forecasting avoids over production, lost energy, and degradation of the machines. IT also avoids having to use expensive backups when we run out.

Lower CO_2 emissions => fewer carbon credits / lower emissions penalty / better compliance with government regulation.

Competitive differentiation compared to other energy distributors in France and even all over the world.

protection against fossil fuels volatility and taxes

impact of solution on business & environment

NEGATIVE IMPACTS

Some startups offer similar solutions to the one we are proposing, but without ever encompassing the bigger, broader solution which is distributing carbon emission free energy. Therefore, Engie could be accused of unfair competition or of stealing market shares of french startups instead of buying them or collaborating with them.

Data privacy: since Engie needs very precise data to predict peak usage from users and companies, It has access to lots of data from its clients. Implementing AI in more parts of the business means more connectivity between activities and potentially higher risk with data protection.

Dependency on third party data

impact of solution on business & environment

POSITIVE IMPACTS
Increased and fully known Share of renewables in the mix
increased knowledge on renewables & how to produce/collect them efficiently, which benefits society as a whole. Not just benefitting Engie.
push companies to have more transparency on carbon emissions, because Engie's solution will be less expensive.
This transforms the way we see renewables: they no longer are a luxury, than only some people can afford if they have solar panels. It becomes a commodity, that anyone can and needs to have access to, at all times. People will now see fossil fuels as "emergency" energy, that we can use when renewables run out.

impact of solution on business & environment

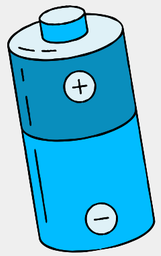
NEGATIVE IMPACTS

Need a powerful AI prediction system to be as accurate as possible. Lots of energy and water consumed. But at the same time, renewable energies consume less water than fossil fuels for cooling down plants.

Batteries may degrade faster because of aggressive cycling in order to better manage and increase the share of renewables in the mix. They are constantly being emptied and refilled

Extreme weather may bring lack of reliability for the forecasting, but this is of course to be expected with any forecasting algorithm, there is never 100% certainty.

Key Risks & Limitations



Battery Capacity & Grid Stability

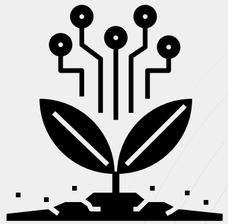
Reason: Current storage capacity and grid coordination may be insufficient to handle renewable production peaks.
Impact: Leads to energy curtailment (loss of excess renewable energy), reducing efficiency and economic value of the solution.

Data Privacy & Security

Reason: Predictive models rely on weather, consumption, and market data, which can be disrupted by exceptional events (heatwaves, geopolitical crises, black swans).
Impact: Inaccurate forecasts can cause grid imbalances, increased balancing costs, or force temporary reliance on fossil fuels.

Forecasting Accuracy

Reason: Predictive models rely on weather, consumption, and market data, which can be disrupted by exceptional events (heatwaves, geopolitical crises, black swans).
Impact: Inaccurate forecasts can cause grid imbalances, increased balancing costs, or force temporary reliance on fossil fuels.



Technology Adoption & Integration

Reason: Legacy infrastructure and complex grid systems (SCADA, EMS) make it difficult to integrate AI solutions smoothly. Energy providers may also hesitate to adopt new, unfamiliar technologies.
Impact: Technical and operational delays, higher implementation costs, and resistance from operators slow deployment.

Key Risks & Limitations

Trust, Transparency & User Acceptance Risk

Reason: Operators and regulators may be skeptical of “black-box” AI systems that lack explainability or proven reliability.

Impact: Without transparent KPIs and clear decision logic, users may resist relying on AI predictions for critical grid management decisions.

Economic, Market & Financial Risk

Reason: Profitability depends on renewable monetization mechanisms (spot prices, carbon credits, etc.) and client willingness to invest. Initial deployment and data acquisition can be costly.

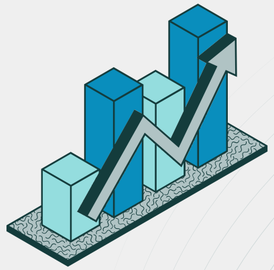
Impact: Market fluctuations or reduced incentives can weaken business performance and slow adoption.

Regulatory & Policy Risk

Reason: Energy regulations and carbon policies evolve slower than technology. Future changes in subsidies, carbon pricing, or renewable incentives are unpredictable.

Impact: Creates uncertainty about financial returns and may affect the platform’s long-term viability.

Scalability & Operational Stability Risk



Reason: Expanding predictive AI across diverse geographies introduces challenges — varying regulations, climates, and grid configurations. Additionally, poor storage management or inaccurate predictions may threaten grid stability.

Impact: Slower scaling, potential outages, and loss of confidence in ENGIE’s reliability.

Conclusion

Greenflow - AI for Smarter Energy

- **GreenFlow** reflects **ENGIE's** drive to lead the **renewable transition** through AI innovation.
- By combining **predictive intelligence** with **real-time grid control**, it turns renewable variability into efficiency, **reducing fossil dependence** and improving grid stability.
- The solution **unlocks lost renewable potential**, cuts operational costs, and strengthens ENGIE's position as a global sustainability leader.
- Its explainable AI ensures transparency, trust, and easy integration with existing systems.

Conclusion

Greenflow - AI for Smarter Energy

Impact:

- Boosts profitability and resilience against market volatility.
- Empowers clients with cleaner, traceable energy.
- Accelerates progress toward carbon neutrality.

Through robust data governance, transparent AI, and strategic partnerships, GreenFlow positions ENGIE as a pioneer of intelligent decarbonization — transforming energy data into both climate impact and long-term financial performance.

GreenFlow isn’t just about powering the grid — it’s about powering the future.

Greenflow

Thank You For Attending

ENGIE

skema BUSINESS SCHOOL

Sources & Appendices

1. ENGIE. (2024). Corporate Reports and White Papers. ENGIE. https://www.engie.com/en/investors/publications
2. International Energy Agency (IEA). (2021). Renewables 2021. https://www.iea.org/reports/renewables-2021
3. European Commission. (2021). Proposal for a Regulation laying down harmonized rules on artificial intelligence (Artificial Intelligence Act). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0206
4. Liu, J., & Wang, Y. (2019). A survey on applications of digital twin in the energy sector. Energy Procedia, 158, 3443–3448. https://doi.org/10.1016/j.egypro.2019.01.430

Sources & Appendices

5. Wan, C., Li, Z., & Wang, X. (2021). AI for renewable energy forecasting: A review. Renewable and Sustainable Energy Reviews, 149, 111297. https://doi.org/10.1016/j.rser.2021.111297
6. Lee, J., Bagheri, B., & Jin, C. (2016). Introduction to Cyber Manufacturing Systems. Manufacturing Letters, 8, 11–15. https://doi.org/10.1016/j.mfglet.2016.09.001
7. Guo, L., et al. (2020). AI-enabled predictive maintenance for smart energy systems: A review. IEEE Transactions on Industrial Informatics, 16(6), 3905–3914. https://doi.org/10.1109/TII.2020.2974442
8. Green Software Foundation. (2023). Principles for Sustainable Software Engineering. https://greensoftware.foundation/principles/
9. Internal sources/Service providers. (Undisclosed)
10. Neoen website (2025) https://neoen.com/fr/
11. Voltalia service mission website (2025) https://www.voltalia.com/service-provider
12. Engie impact website (2023) https://www.engieimpact.com/capabilities/carbon-management