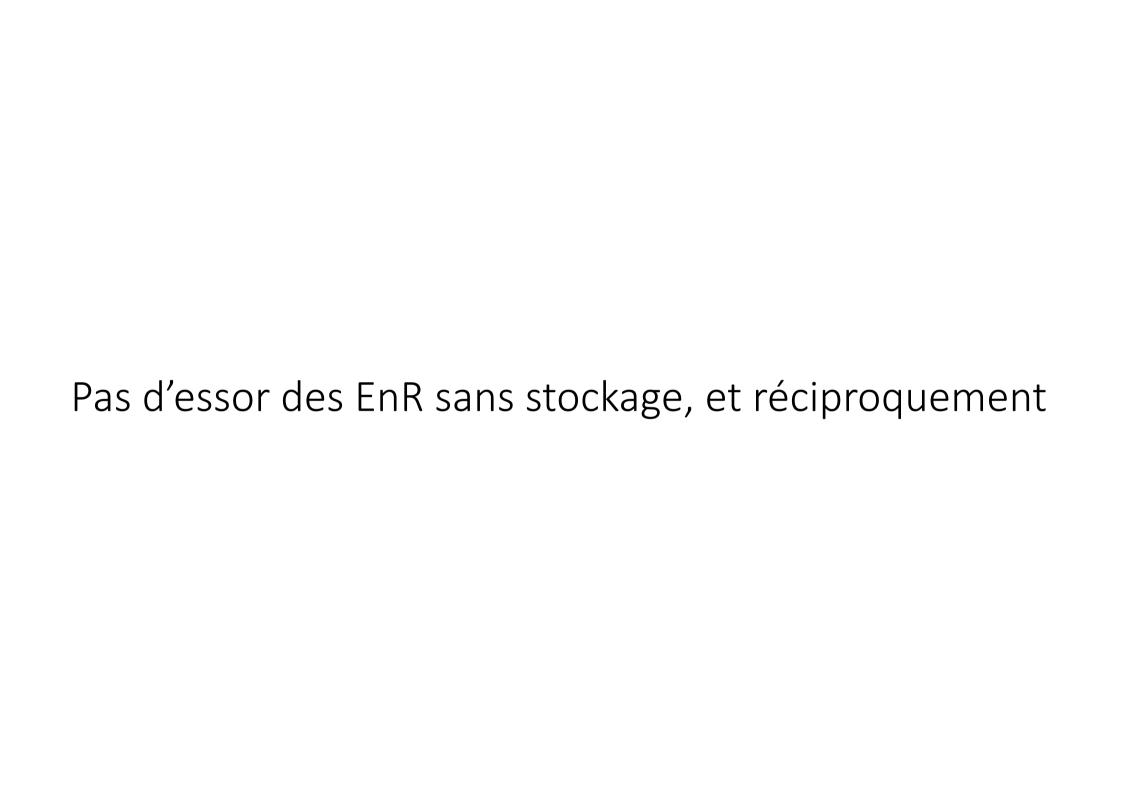
Eléments d'économie du stockage de l'électricité

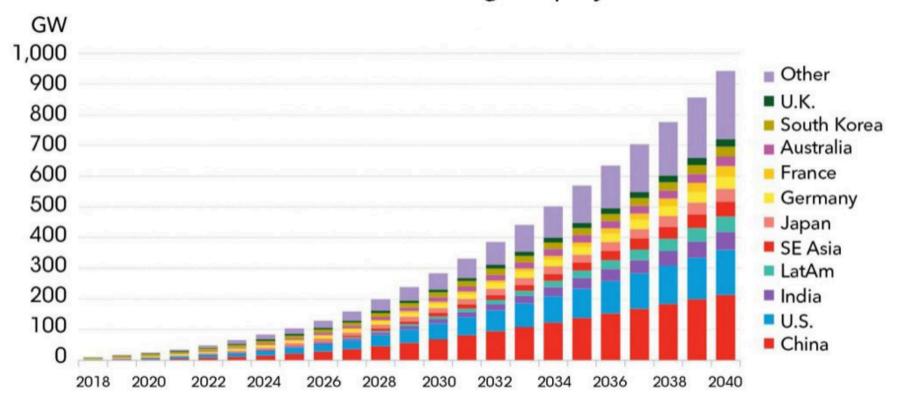
Quels services le stockage peut-il apporter ?

Table-ronde RegulaE.Fr François Lévêque, Mines ParisTech Cotonou, 3 juillet 2019





Global cumulative storage deployments



Source: BloombergNEF

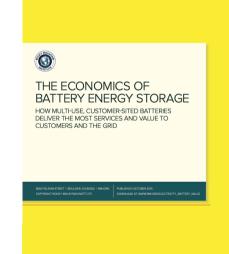
prix de marché faible → stockage → prix de marché élevé

valeur d'usage faible → stockage → valeur d'usage élevée

ENERGY STORAGE VALUES VARY DRAMATICALLY Service Value [\$/kW-year] **ACROSS LEADING STUDIES** \$100 \$200 \$300 \$400 \$500//\$900 **Energy Arbitrage** Frequency Regulation ISO/RTO Spin / Non-Spin Reserves **X** 🗶 🔳 **SERVICES** Voltage Support Black Start Resource Adequacy **Distribution Deferral** UTILITY **SERVICES Transmission Congestion Relief** Transmission Deferral Time-of-Use Bill Management **CUSTOMER** Increased PV Self-Consumption **SERVICES Demand Charge Reduction Backup Power**

Results for both energy arbitrage and load following are shown as energy arbitrage. In the one study that considered both, from Sandia National Laboratory, both results are shown and labeled separately. Backup power was not valued in any of the reports.





Tout seul le stockage ne sert à rien

Pour que ça marche, il faut des biens et services complémentaires



















FENIX, the Solar Home System company of ENGIE



Power for lights, radio, phone charging, TV and more

10W-60W expandable solar power platform designed & manufactured by Fenix

Integrated lockout technology to enable flexible and affordable financing over mobile money platform

Supports wide accessory ecosystem allowing customers to upgrade overtime

12V, long-lasting Lithium Iron Phosphate battery

Plug & play design and designed for both home and business use



Fenix (400 FTE) has its main activities in Uganda where it is the leading SHS player with more than 200,000 customers

Fenix recently launched operations in Zambia in late 2017 and Cote d'Ivoire in early 2018. Fenix plans further rollouts in other countries across Africa in the next fives years impacting millions of people living off-grid.

How FENIX SHS work?

Customer receives SMS with unlock code



Customer enters code using their remote

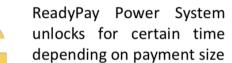




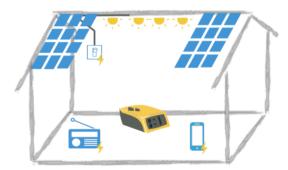


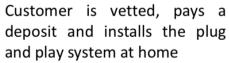


FenixDB receives payment, generates unlock code and automatically sends SMS



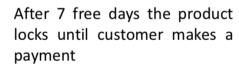










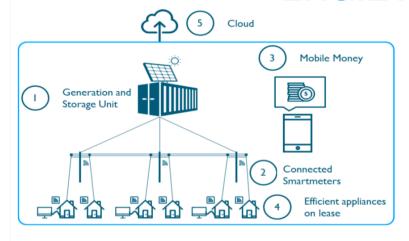






Customer makes payments starting at \$0.15/day via Mobile Money for 24-36 months

ENGIE Africa Power Corner







Generation & storage

- Solar PV
- Battery
- Containerized solution

Distribution

- AC voltage
- Mono or triphase
- Smart meter

Micro Utility Platform

- Mobile money payment
- Activity monitoring
- Digital backbones

- 13 PowerCorner in Tanzania & 1 in Zambia
- Presence in 2 to 5 new countries next Year
- Ambition of thousands Power Corner to industrialize the solution

Bluezone de Zongo









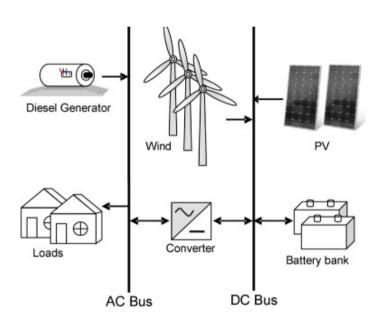




Deux biens peuvent être à la fois complémentaires et substituables Tout dépend des coûts et des usages

A et B sont substituables : prix (A) augmente → quantité (B) augmente A et B sont complémentaires : prix (A) augmente → quantité (B) diminue

Le PV associé au stockage peut remplacer le diesel en partie ou en totalité





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Optimal sizing of PV/wind/diesel hybrid microgrid system using multi-objective self-adaptive differential evolution algorithm



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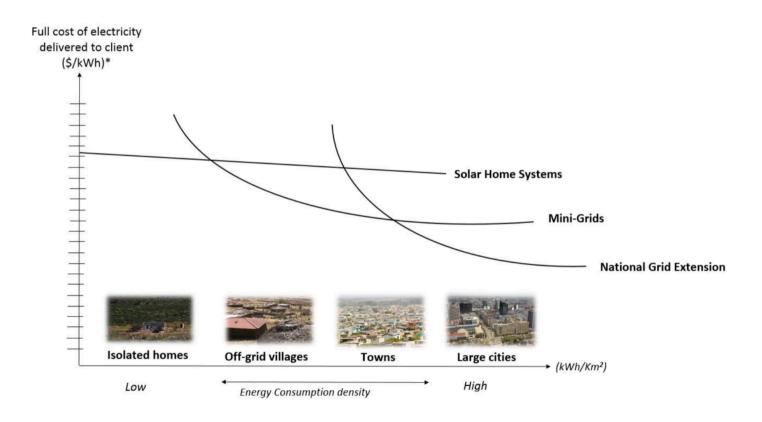
Keywords:
Hybrid system
Renewable energy
Wind energy
PV
Optimization
Differential evolution algorithm

$A\ B\ S\ T\ R\ A\ C\ T$

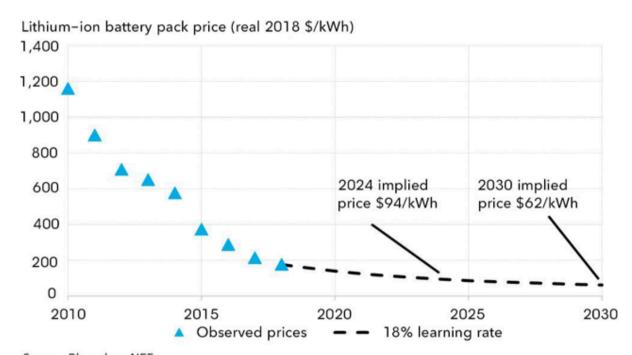
Microgrid systems, such as solar photovoltaic (PV) power and wind energy, integrated with diesel generators are promising energy supplies and are economically feasible for current and future use in relation to increased demands for energy and depletion of conventional sources. It is thus important to optimize the size of hybrid microgrid system (HMS) components, including storage, to determine system cost and reliability. In this paper, optimal sizing of a PV/wind/diesel HMS with battery storage is conducted using the Multi-Objective Self-Adaptive Differential Evolution (MOSaDE) algorithm for the city of Yanbu, Saudi Arabia. Using the multi-objective optimization approach, the objectives are treated simultaneously and independently, thereby leading to a reduction in computational time. One of the main criteria to consider when designing and optimizing the HMS is the energy management strategy, which is required to coordinate the different units comprising the HMS. The multi-objective optimization approach is then used to analyze the Loss of Power Supply Probability (LPSP), the Cost of Electricity (COE), and the Renewable Factor (RF) in relation to HMS cost and reliability and is tested using three case studies involving differing house numbers. Results verify its application in optimizing the HMS and in its practical implementation. In addition, optimization results using the proposed approach provided a set of design solutions for the HMS, which will assist researchers and practitioners in selecting the optimal HMS configuration. Moreover, it is important to select optimally sized HMS components to ensure that all load demands are met at the minimum energy cost and high reliability.

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Le stockage a partout sa place



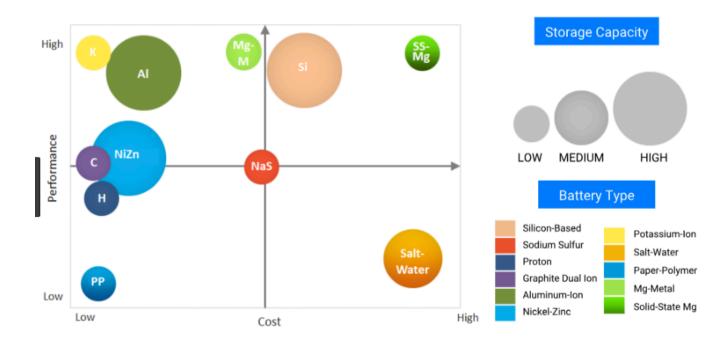
Effets d'apprentissage



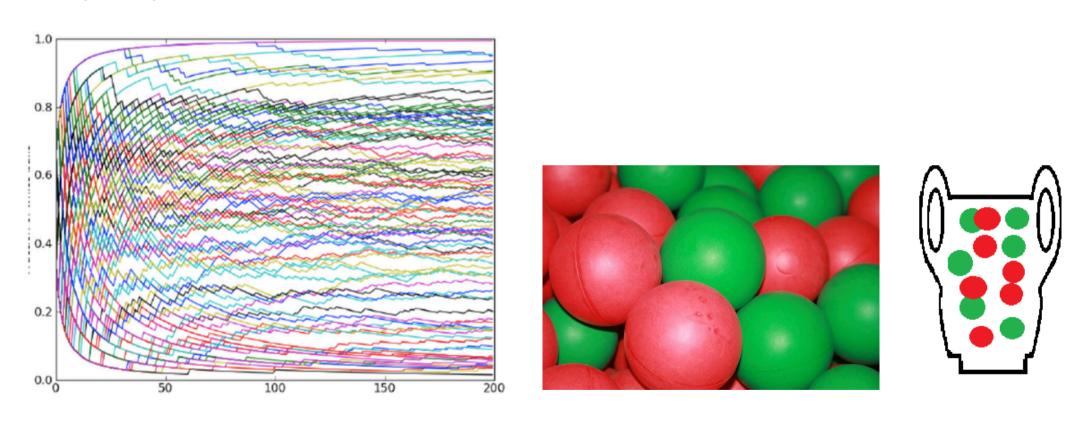
Source: BloombergNEF

Economie d'apprentissage : diminution du coût de X% quand le nombre d'unités produites ou installées double

Une technologie n'est pas choisie car elle est plus performante mais c'est parce qu'elle est plus adoptée qu'elle devient plus performante



Les choix initiaux sont déterminants et les prophéties autoréalisatrices



Pour conclure

- Le stockage de l'électricité est le complément naturel des énergies renouvelables intermittentes
- Mais ne peut donner toute sa puissance qu'associé à bien d'autres biens et services
- Y compris au diesel pour en limiter l'usage à défaut de le supprimer
- Le stockage ne se limite pas à l'électricité rurale et aux micro-réseaux
- Il peut être associé au système électrique centralisé et se développer en zone urbaine
- Attention de ne pas verrouiller les choix technologiques par des décisions de régulation trop précoces