

Data science for renewables: forecasting and asset management

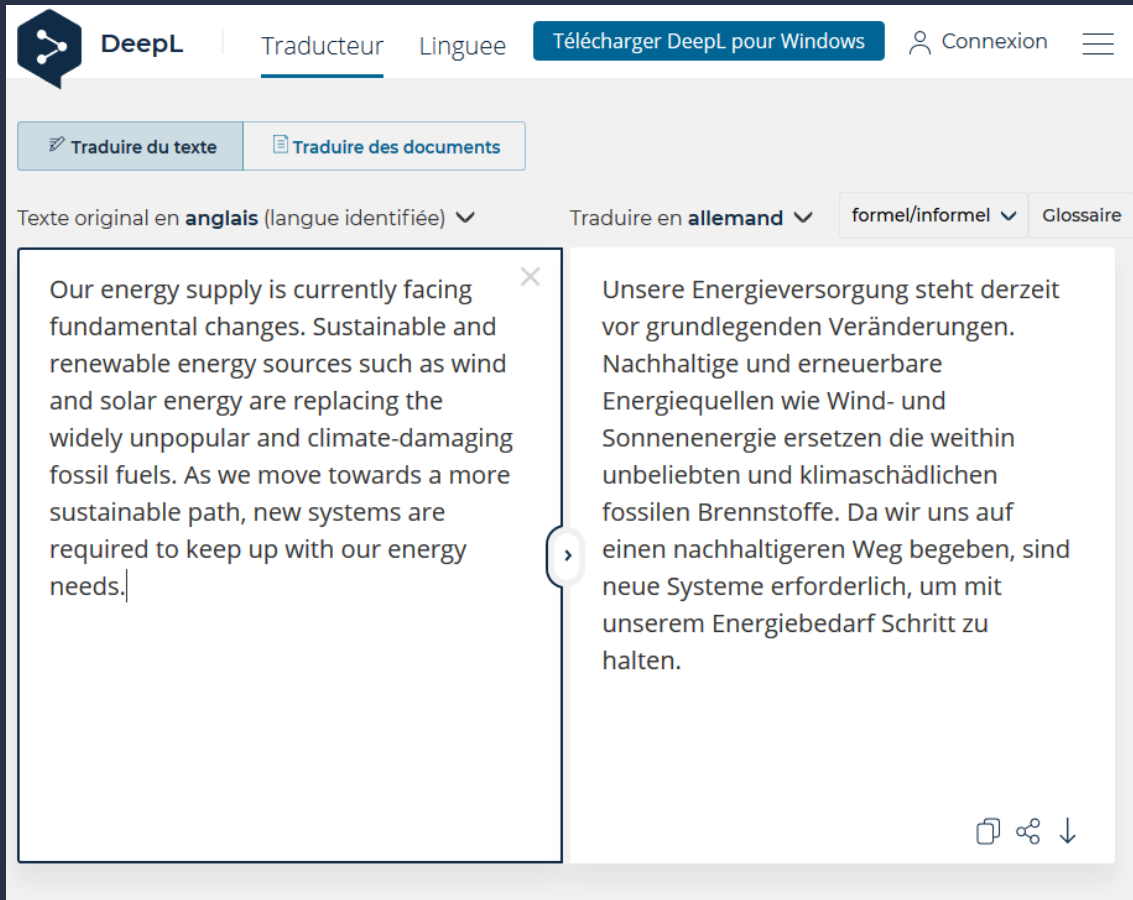
Pierre-Jean Alet, CSEM

Technology Briefing – Smart Energy Applied Solutions

11 Nov. 2020

Data science...

...for renewables?



The screenshot shows the DeepL website interface. At the top, there is a navigation bar with the DeepL logo, the word 'Traducteur', a 'Linguee' link, a 'Télécharger DeepL pour Windows' button, and a 'Connexion' link. Below this, there are two tabs: 'Traduire du texte' (selected) and 'Traduire des documents'. The main area shows a translation of a paragraph from English to German. The source text is in English, and the target text is in German. The interface also includes dropdown menus for selecting the source and target languages, and a 'Glossaire' link.

Texte original en **anglais** (langue identifiée) ▼ Traduire en **allemand** ▼ formel/informel ▼ Glossaire

Our energy supply is currently facing fundamental changes. Sustainable and renewable energy sources such as wind and solar energy are replacing the widely unpopular and climate-damaging fossil fuels. As we move towards a more sustainable path, new systems are required to keep up with our energy needs.

Unsere Energieversorgung steht derzeit vor grundlegenden Veränderungen. Nachhaltige und erneuerbare Energiequellen wie Wind- und Sonnenenergie ersetzen die weithin unbeliebten und klimaschädlichen fossilen Brennstoffe. Da wir uns auf einen nachhaltigeren Weg begeben, sind neue Systeme erforderlich, um mit unserem Energiebedarf Schritt zu halten.



Data from renewables



Algorithmics: transfer between application domains

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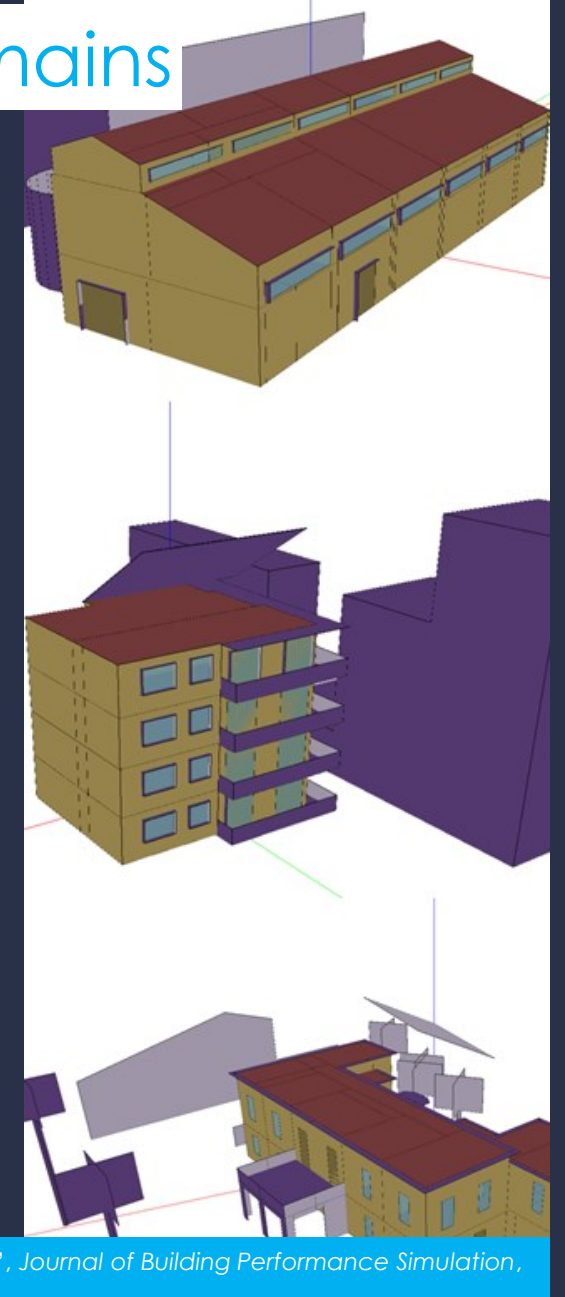
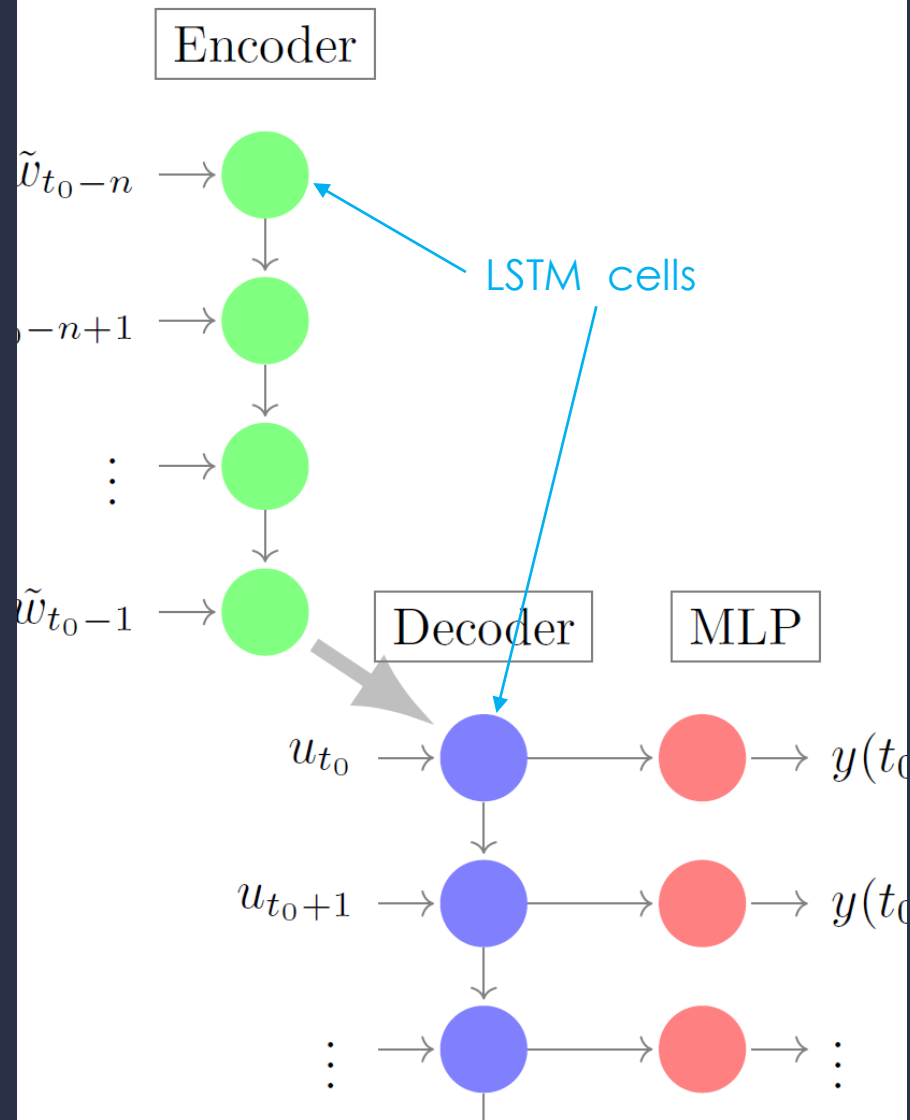
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Unsere Energie vor grundlegenden Nachhaltigkeitszielen. Energiequelle: Sonnenenergie. unbeliebte fossilen Brennstoffen. einen nachhaltigen neuen Systemen. unserem Erhalt.





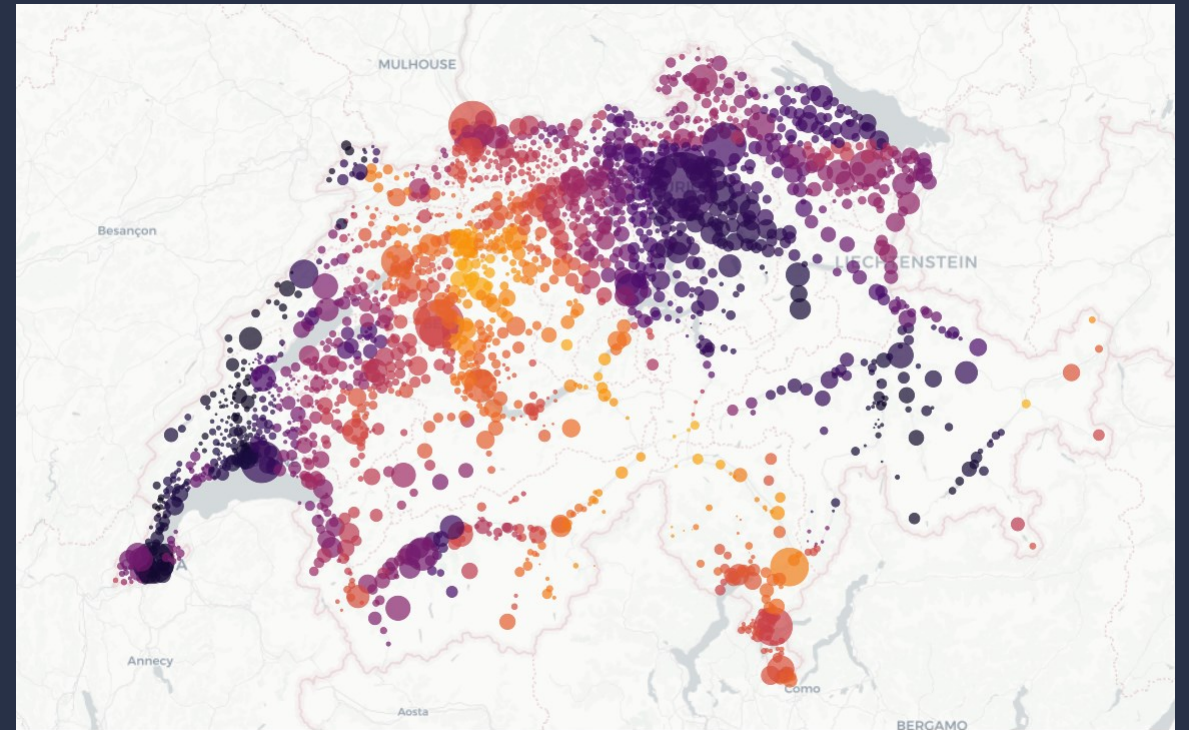
Use cases

- **Reducing** energy consumption
- Accommodating **more renewables** into the **grid**
- Getting more out of renewable generation **assets**



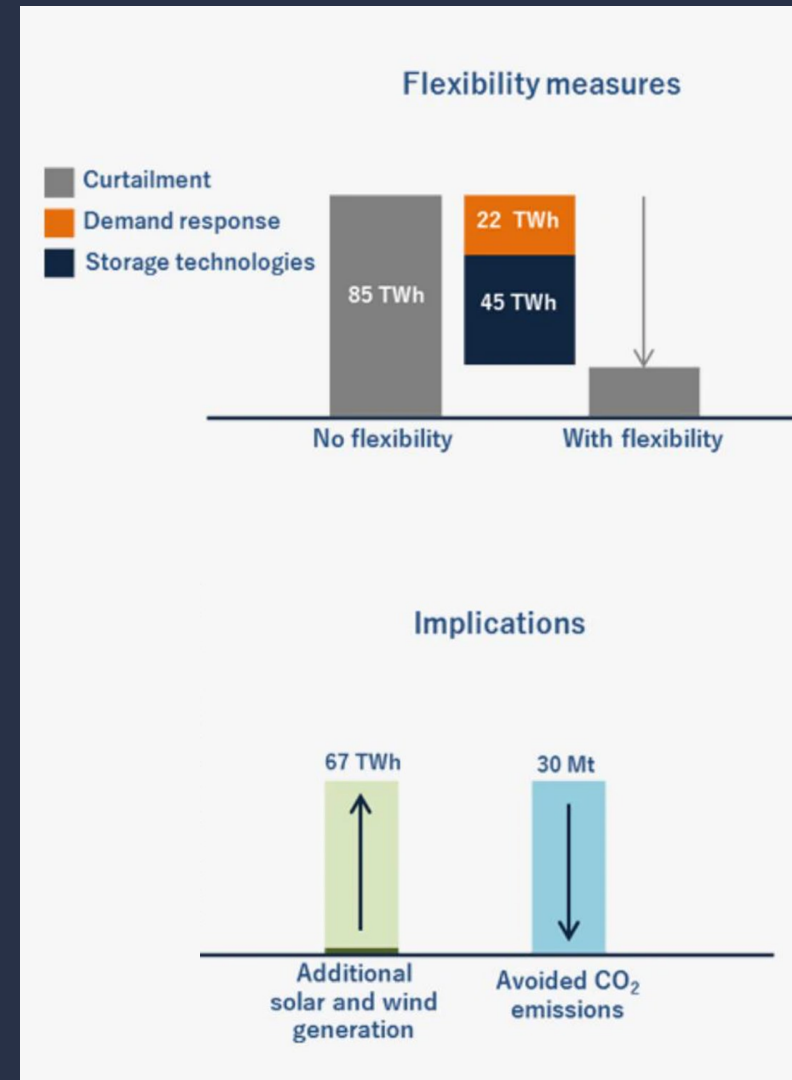
Challenges for integrating renewables in the grid

- Spatial distribution
- Random fluctuations of PV, wind
- Lower capacity factor



Data-driven solutions to integrate renewables

- Data-driven control for
 - Flexibility
 - Power quality
- Prerequisite: forecasting



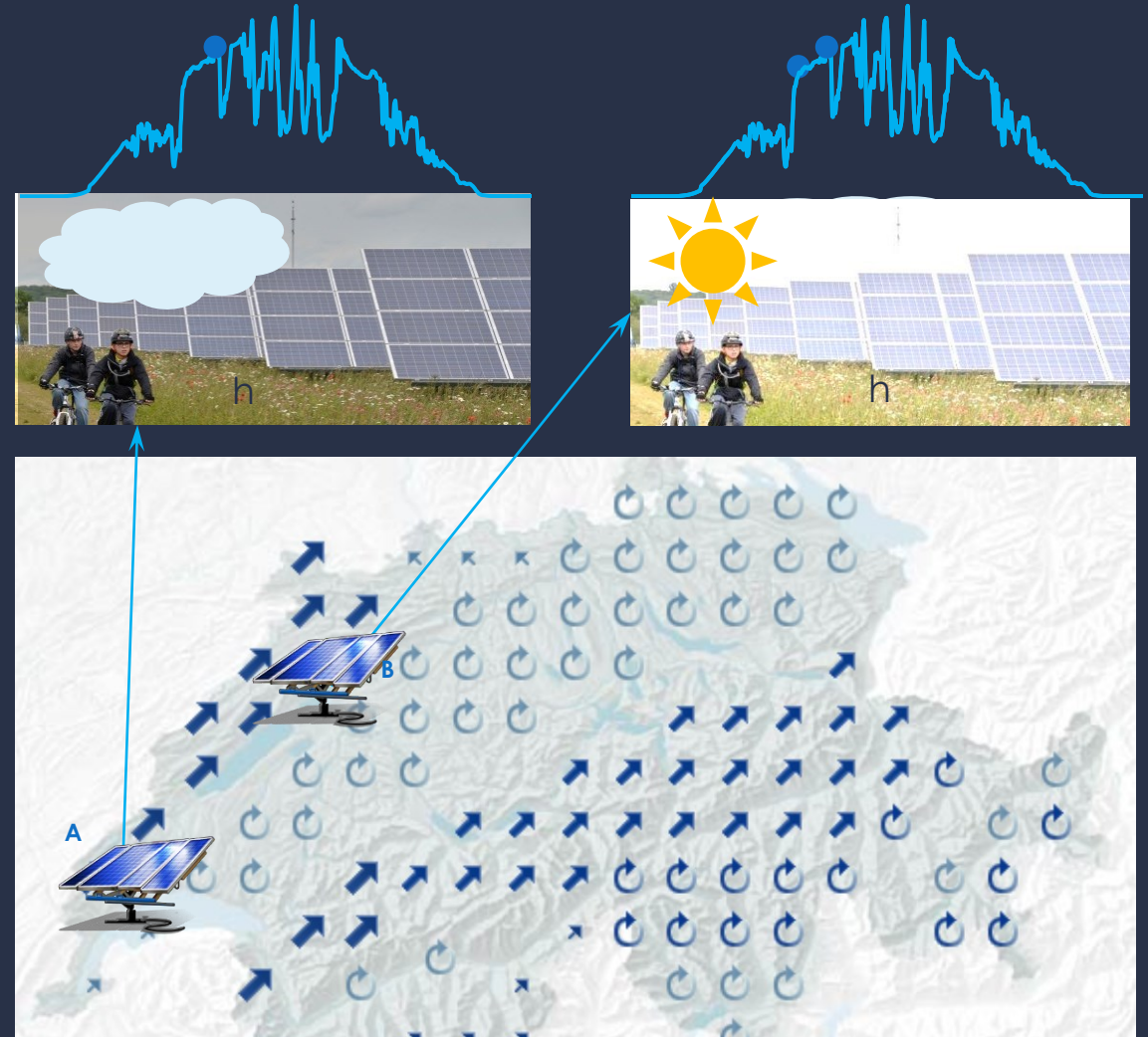
Data-driven forecasting: intuition

PV system \approx weather station

Spatial correlation

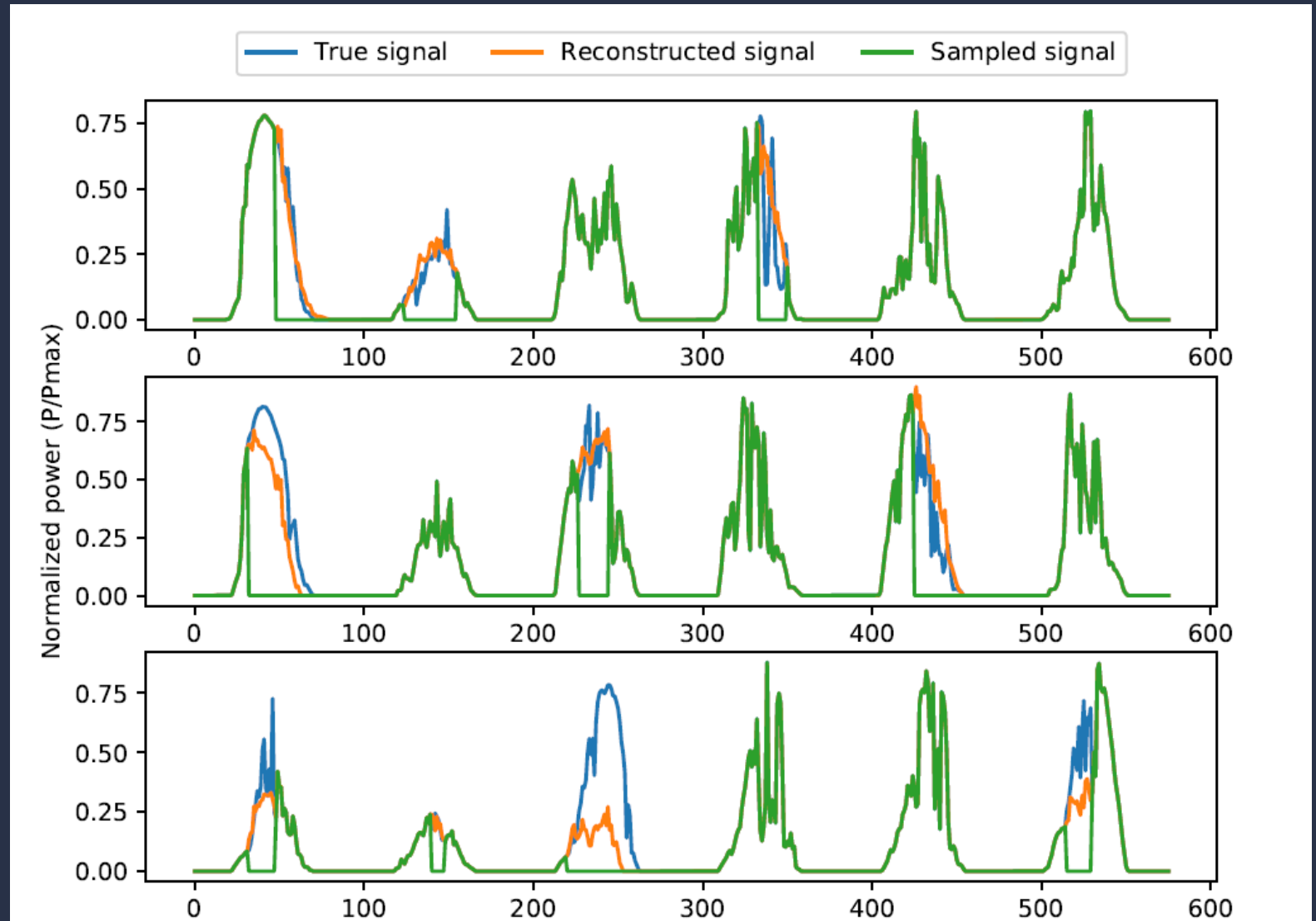


Temporal correlation



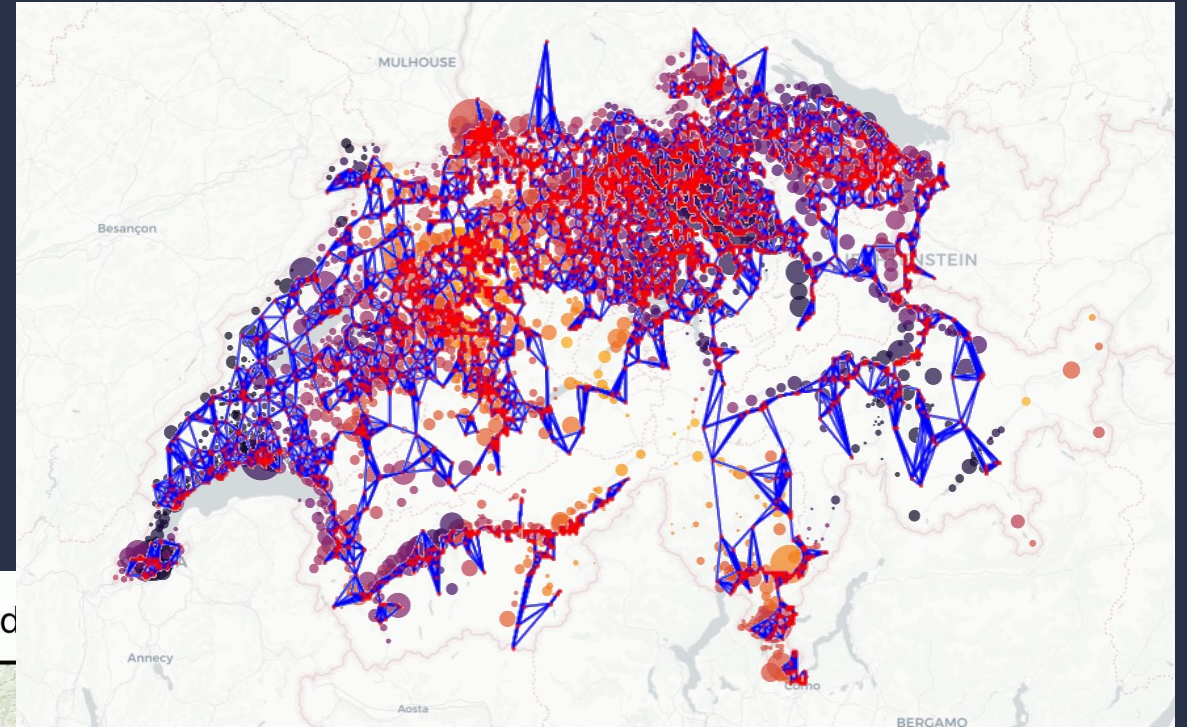
Data quality challenge

- Required for machine learning: **clean** and **uninterrupted** data
- Real life: **incomplete, noisy** data
- Solution for **reconstruction?**

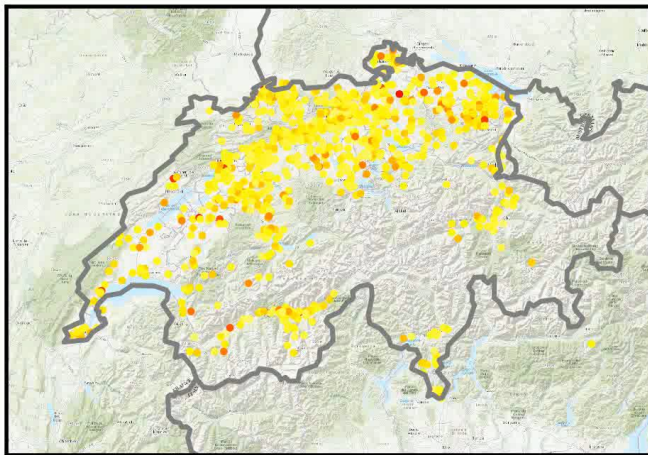


Data-driven forecasting: solution

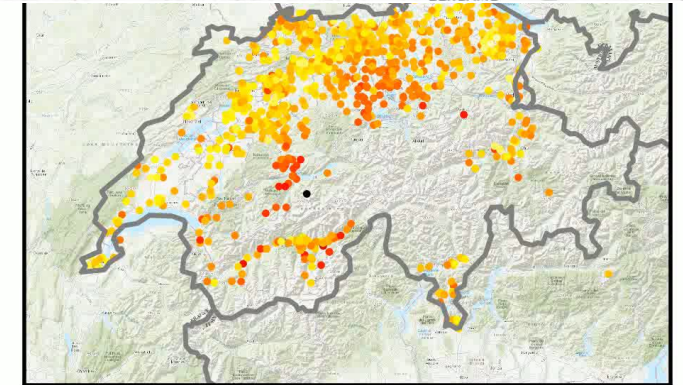
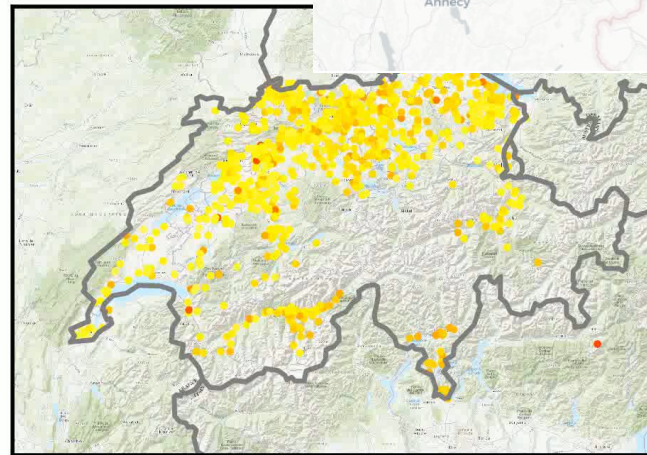
- Graph machine learning (← social networks)
- High spatial and temporal resolution
- Beats numerical weather forecasts up to 5h ahead



Current



Predicted



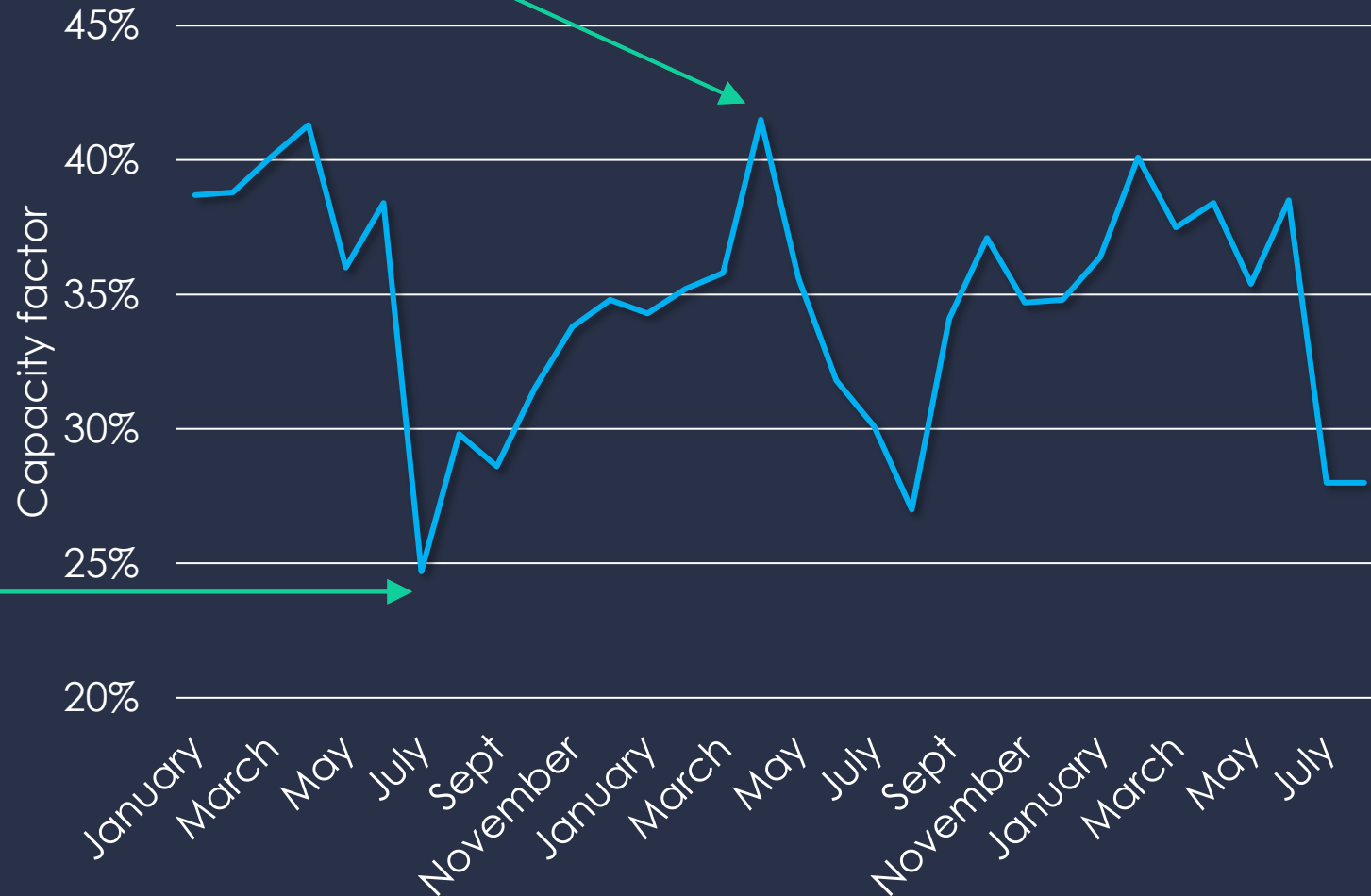
R. E. Carrillo, M. Leblanc, B. Schubnel, R. Langou, C. Topfel, and P.-J. Alet, 'High-Resolution PV Forecasting from Imperfect Data: A Graph-Based Solution', *Energies*, vol. 13, no. 21, Art. no. 21, Nov. 2020, doi: [10.3390/en13215763](https://doi.org/10.3390/en13215763).

Getting more from renewable generation assets

Want max availability

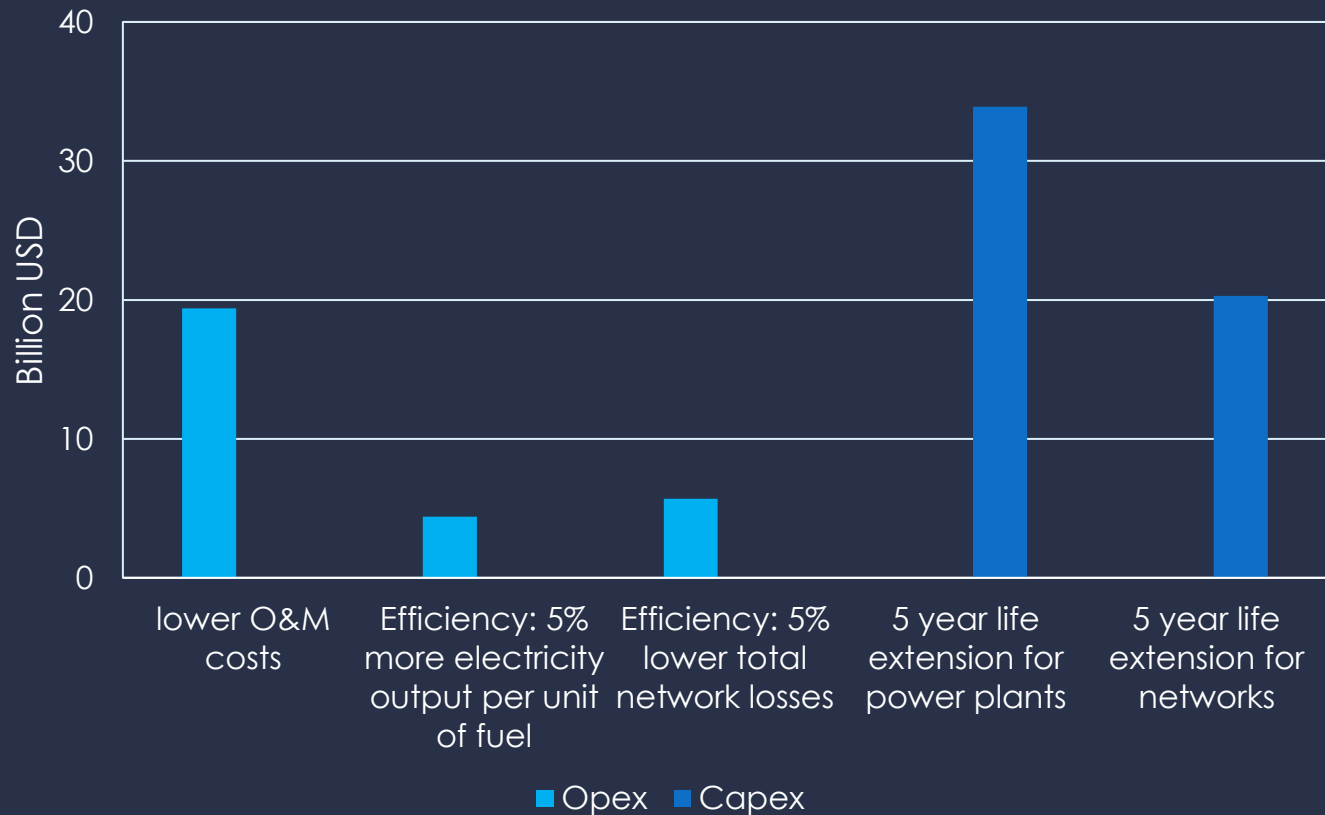
Wind production in the USA

OK to do maintenance



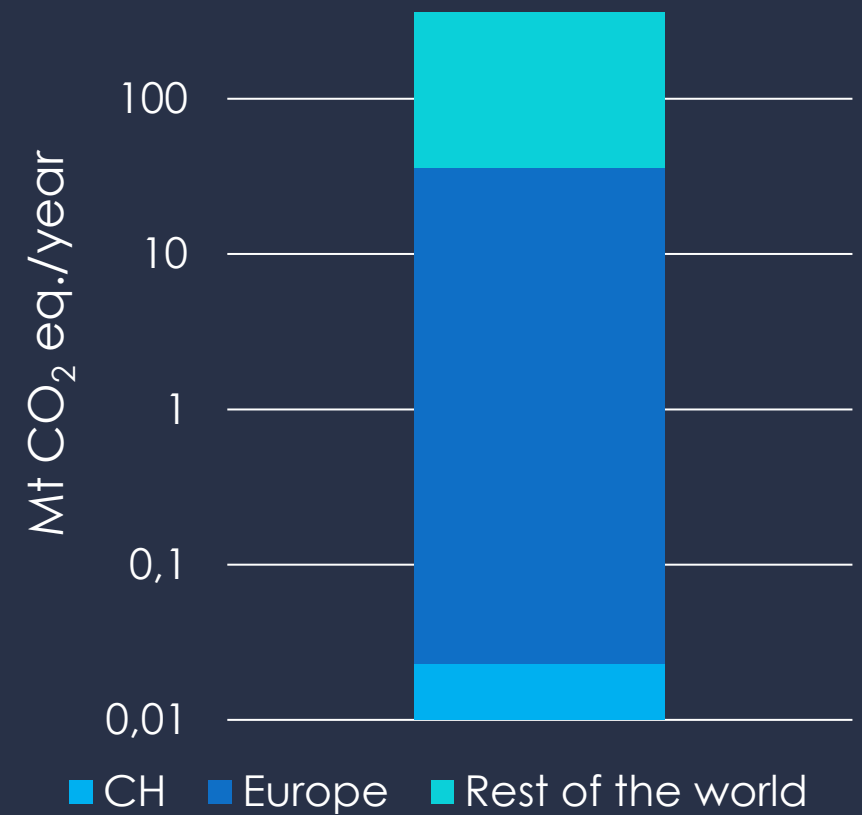
Asset management: impact

Worldwide cost savings from enhanced digitalisation in power plants and electricity networks over 2016-2040



IEA, Worldwide cost savings from enhanced digitalisation in power plants and electricity networks over 2016-2040, IEA, Paris <https://www.iea.org/data-and-statistics/charts/worldwide-cost-savings-from-enhanced-digitalisation-in-power-plants-and-electricity-networks-over-2016-2040>

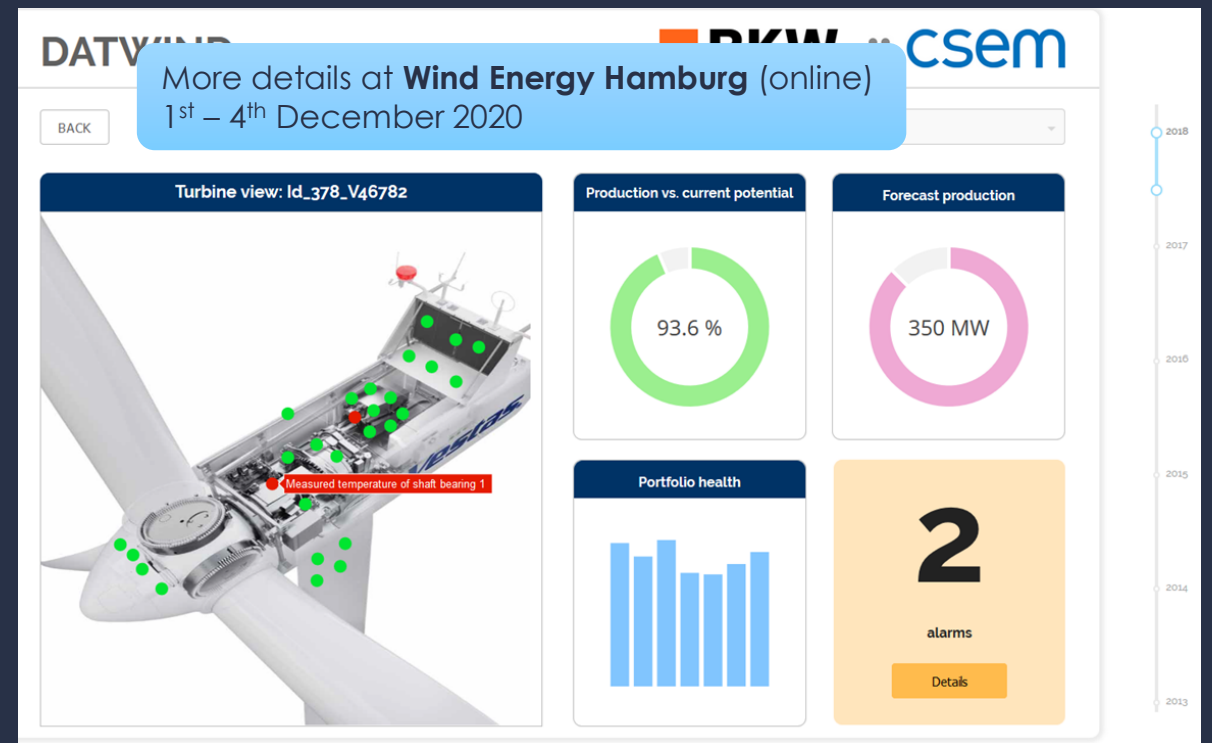
Reduction in greenhouse gas emissions by 2040



Asset management: solution

- Machine learning on historical data
- Intelligent alarm triggering:
 - Encoding of expert knowledge
 - Latest algorithms from research
- Successful validation on 3 parks
- Solution in productive operations in Switzerland, Italy, France, Spain

Direct collaboration with **BKW** and its subsidiary **Proxima Solutions**



Early software prototype

Conclusions

- Distributed renewables create **need** and **opportunities** for data science
- High economic and environmental potential through:
 - **Energy savings**
 - Improved grid integration (**forecasting**, flexibility, control)
 - **Asset management**
- **Transfer** from pioneer domains
+ **field expertise** → rapid **value creation**

For your application:

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R. E. Carrillo, M. Leblanc, B. Schubnel, R. Langou, C. Topfel, and P.-J. Alet, 'High-Resolution PV Forecasting from Imperfect Data: A Graph-Based Solution', *Energies*, vol. 13, no. 21, Art. no. 21, Nov. 2020, doi: [10.3390/en13215763](https://doi.org/10.3390/en13215763).

B. Schubnel *et al.*, 'State-space models for building control: how deep should you go?', *Journal of Building Performance Simulation*, vol. 13, no. 6, pp. 707–719, Nov. 2020, doi: [10.1080/19401493.2020.1817149](https://doi.org/10.1080/19401493.2020.1817149).

B. Schubnel, R. E. Carrillo, P.-J. Alet, and A. Hutter, 'A Hybrid Learning Method for System Identification and Optimal Control', *IEEE Transactions on Neural Networks and Learning Systems*, 2020, doi: [10.1109/TNNLS.2020.3016906](https://doi.org/10.1109/TNNLS.2020.3016906).

P. Taddeo *et al.*, 'Management and Activation of Energy Flexibility at Building and Market Level: A Residential Case Study', *Energies*, vol. 13, no. 5, Art. no. 5, Jan. 2020, doi: [10.3390/en13051188](https://doi.org/10.3390/en13051188).