

電力・エネルギー分野における気象データの高度利用



EMS
ENERGY
Management
SYSTEM

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本研究はJST CREST「太陽光発電の予測不確実性を許容する超大規模電力最適配分制御」の中において実施されています。

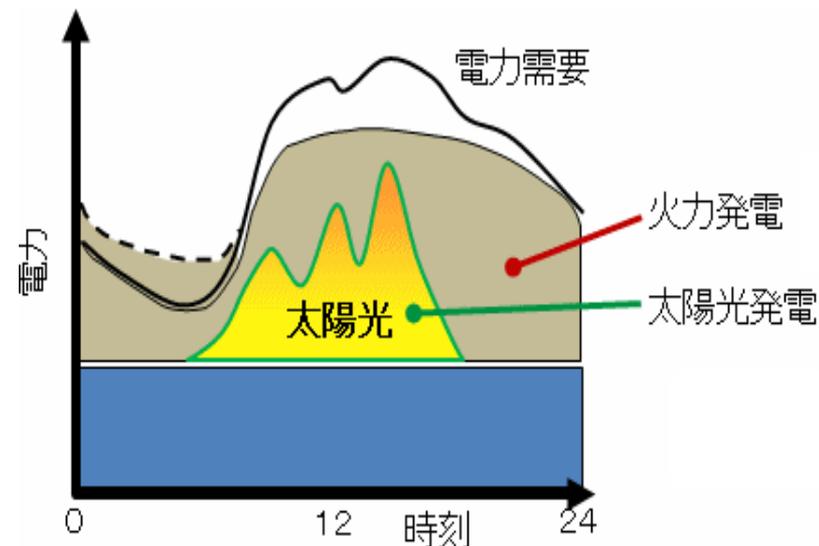
○ 太陽光発電の問題点の一つ

お天気まかせ、時間・空間的な**変動が大きい**
 (安定した電力の供給が求められる)

現状:

- ・FITの導入後、PVの大量導入が加速
- ・電力システムではPVの系統連系△

太陽光発電システムを広く普及、系統連系するには気象予測技術も一つの手段



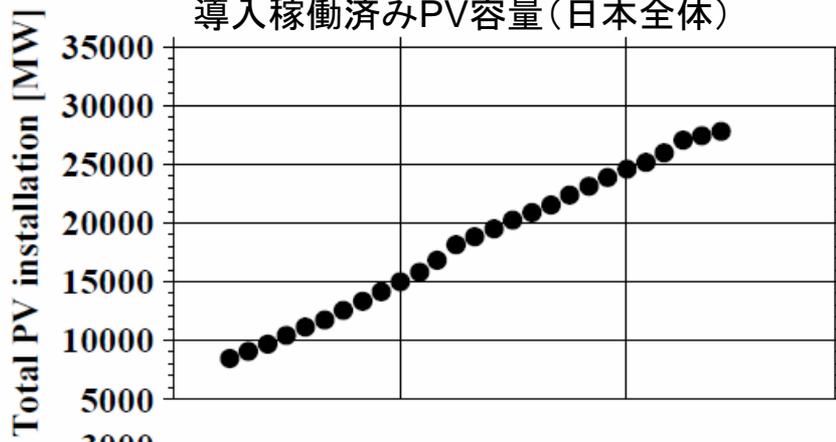
出典: 産総研・太陽光発電研究センターHPより

- ✓ 需要予測に加えて、太陽光による発電予測が必要
- ✓ 火力発電機の運用計画は前日の夕方までに実施(翌日の予測が必要)
- ✓ 計画的、効率的な運用→コスト最小化(経済性) ✓ 出力抑制にも利用

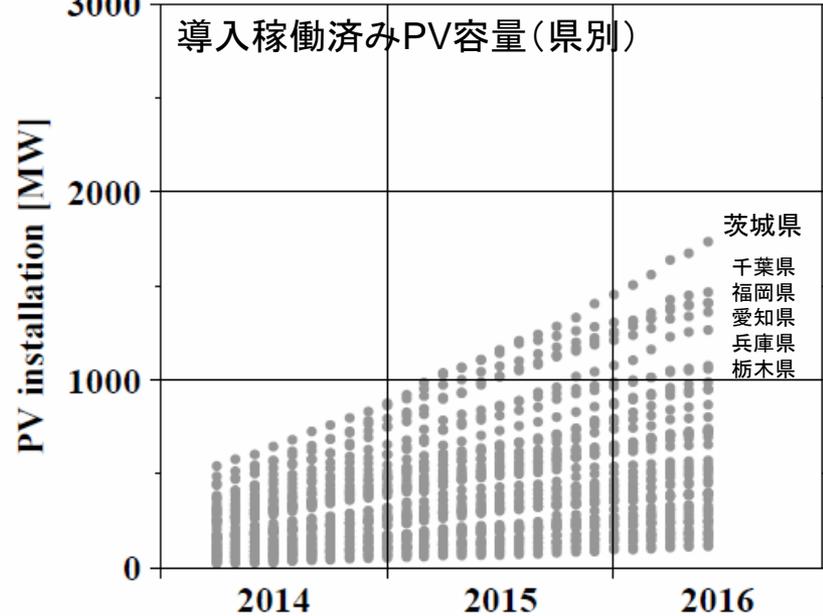
ただし、予測は完全ではなく、現状では大外れすることもある。

B2-1 PV Integ (NEW) ALL

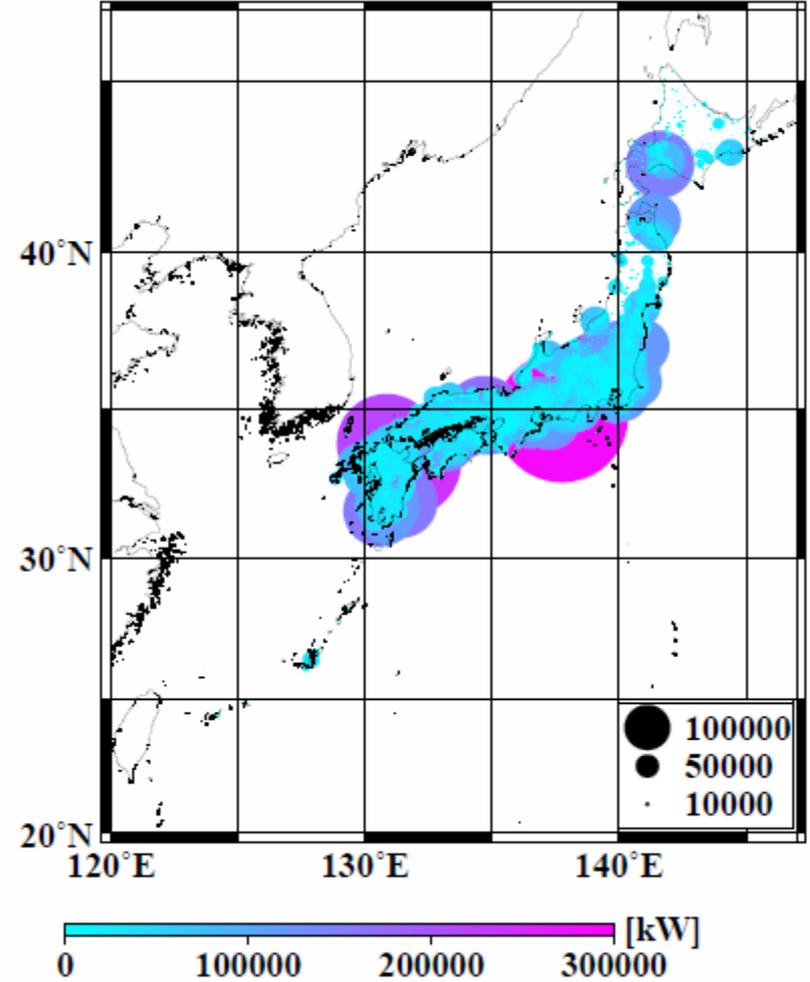
導入稼働済みPV容量(日本全体)



導入稼働済みPV容量(県別)



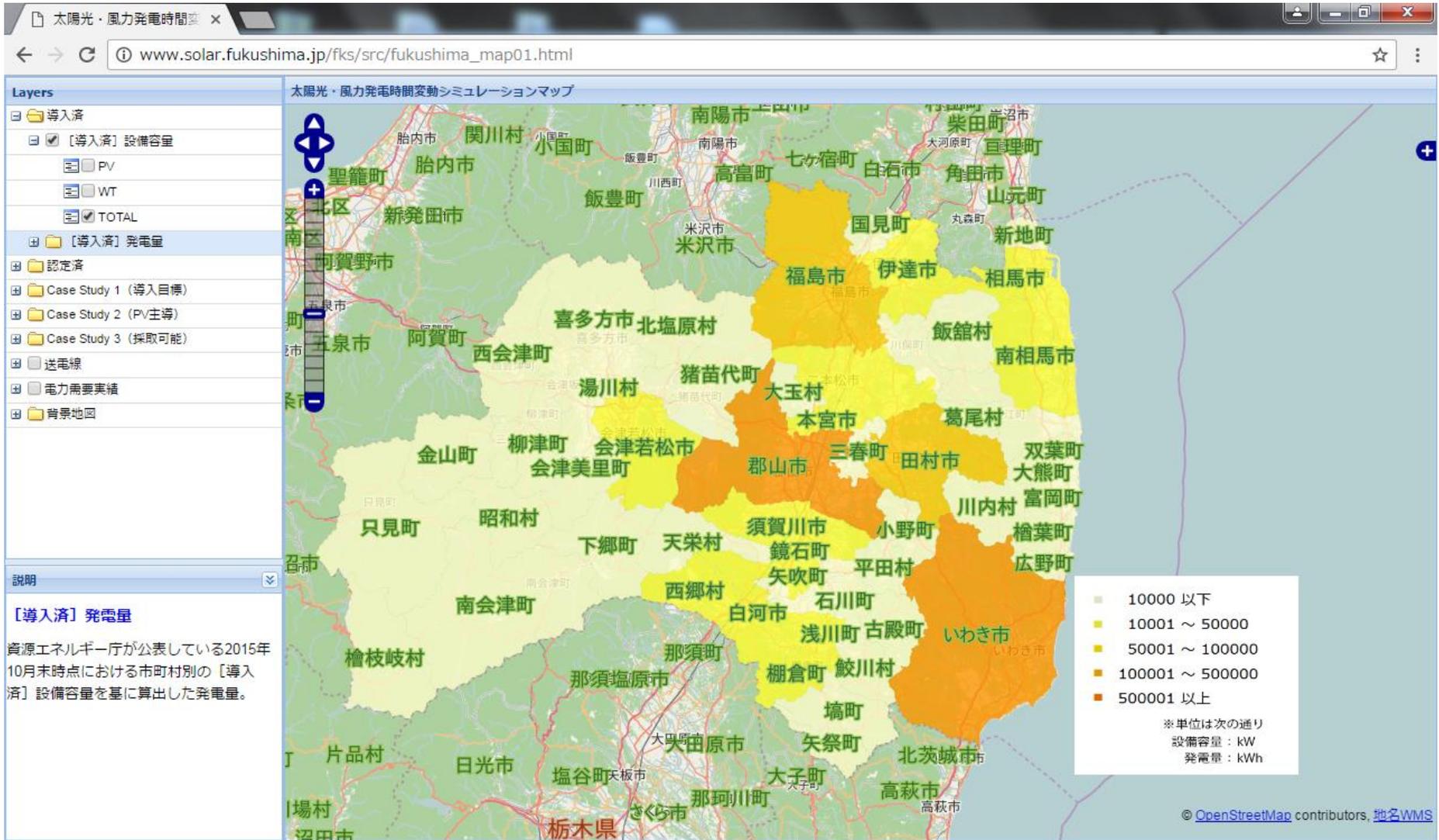
201606 Total 29.1 GW
Max 289.6 MW



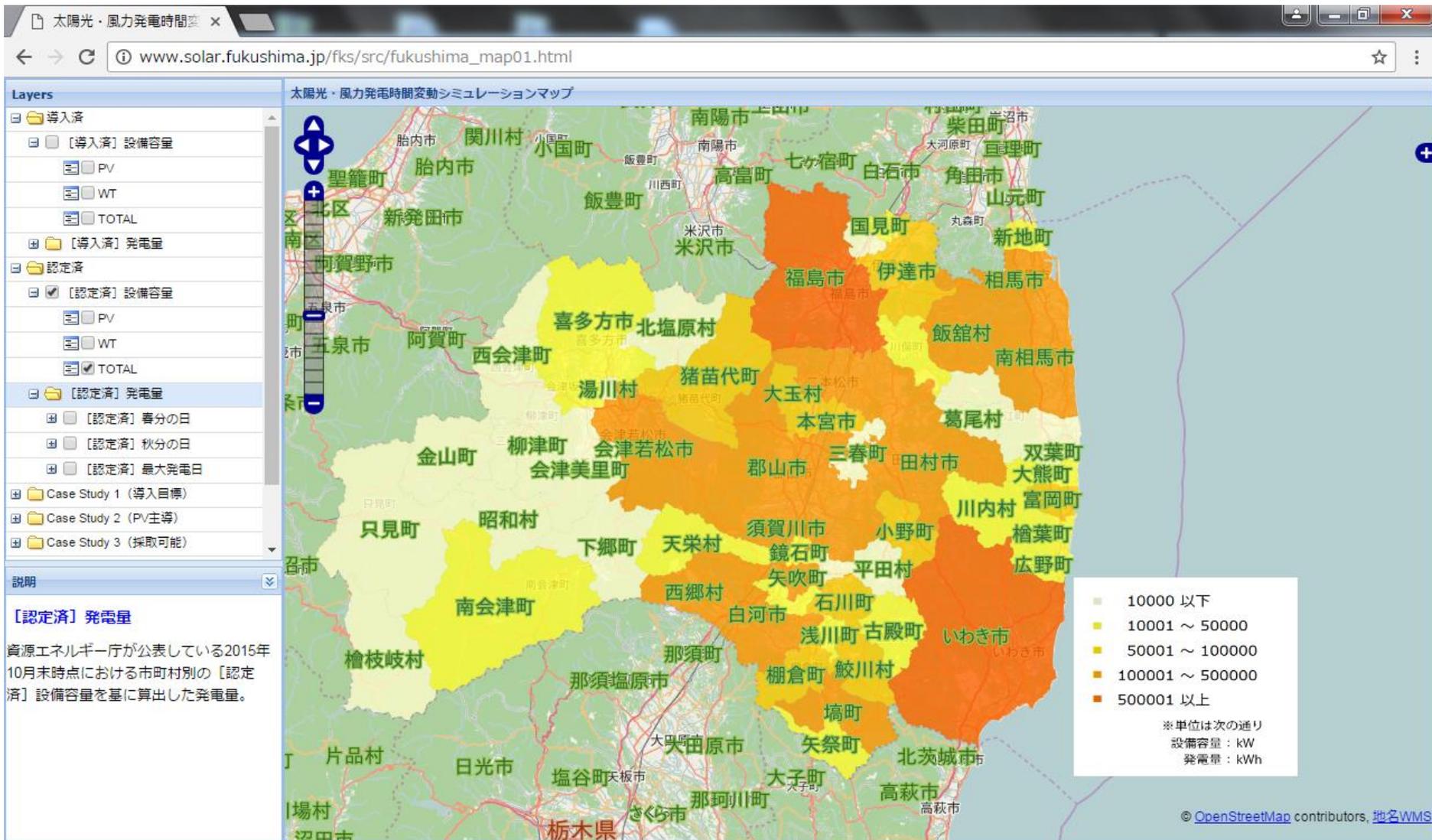
青森県沿岸、宮城・福島県に多い

導入量については「日本の自然エネルギー・データ集」も参考に
<http://www.iseip.or.jp/library/9570>

http://www.solar.fukushima.jp/fks/src/fukushima_map01.html



太陽光・風力発電 導入済み設備容量(2105年10月現在)

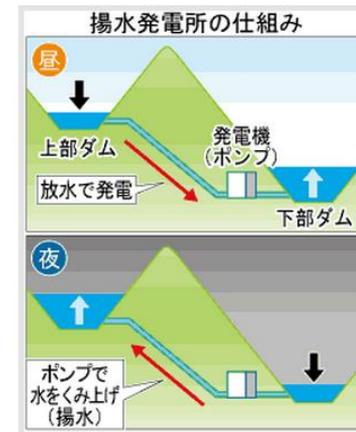


太陽光・風力発電 認定済み設備容量 (将来)

- 発電量の急変動(ramp変動) → 他の電源(火力、揚水発電など)の調整
- 日射・風力発電予測の大外れ → 停電、電力余剰の恐れ
- 発電量の把握
 - ✓ 一部の変電所や大規模メガソーラ、風力発電設備などしか発電情報がわかっていない(発電モニター設備が十分に設置されていない)
 - ✓ 発電量の情報が発電事業者の収益情報になるため、公開されにくい。
- 積雪問題
 - ✓ 降雪があることで日射が遮られる(発電低下)。逆に、融雪するとあるエリアで一斉に発電が発電量上昇。
 - ✓ 雪の重みで損壊
- 火山灰 → 発電システムへの降灰。発電低下。メンテナンスの必要性(洗浄)。事前の保守計画などへ対応。

衛星データ(ひまわり8号・9号)の利用

- 用途1: 太陽光の**発電量ポテンシャル**
- 用途2: 雲・日射の**短時間予測**(雲ベクトル)
数時間先までの雲・日射量の変動を予測
- 用途3: 発電システムの**故障診断**
- 用途4: 配電設備の**事故復旧**



数値予報データの利用(前日、当日予測、気候)

- 用途1: 電力需要の予測
- 用途2: **火力発電機**の起動停止計画(前日夕方までに計画を確定)
- 用途3: **揚水発電、蓄電池**の制御
- 用途4: **送電線**の熱負荷の制御
- 用途5: **積雪・融雪**と発電予測



気候予測データ

- 用途: 電力需要の長期見通し、燃料調達

特集解説

再生可能エネルギーの発電予測とシステム技術

正員 荻本 和彦^{a)}

Generation Forecast of Renewable Energy and System Technology

Kazuhiko Ogimoto^{a)}, Member

(2014年2月24日受付)

The penetration of variable renewable energy generation is bringing about the new issues of variability to a power system operation. The issues are expected to be resolved through the optimum deployment of all the flexibility resources. The paper discusses about the variability and the flexibility to find the needs for the evolution of the forecast technologies and the system technologies of centralized and decentralized power systems.

キーワード：再生可能エネルギー，変動性，柔軟性，発電（出力）予測，システム技術
 Keywords: renewable energy, variability, flexibility, generation forecast, system technology

電力需要から**太陽光発電(PV)**と**風力発電(WIND)**を差し引いた**残余需要**をその他の電源(火力、水力、揚水発電など)でカバーしなければならない。

そのためには、**PVとWINDの予測**が必要。

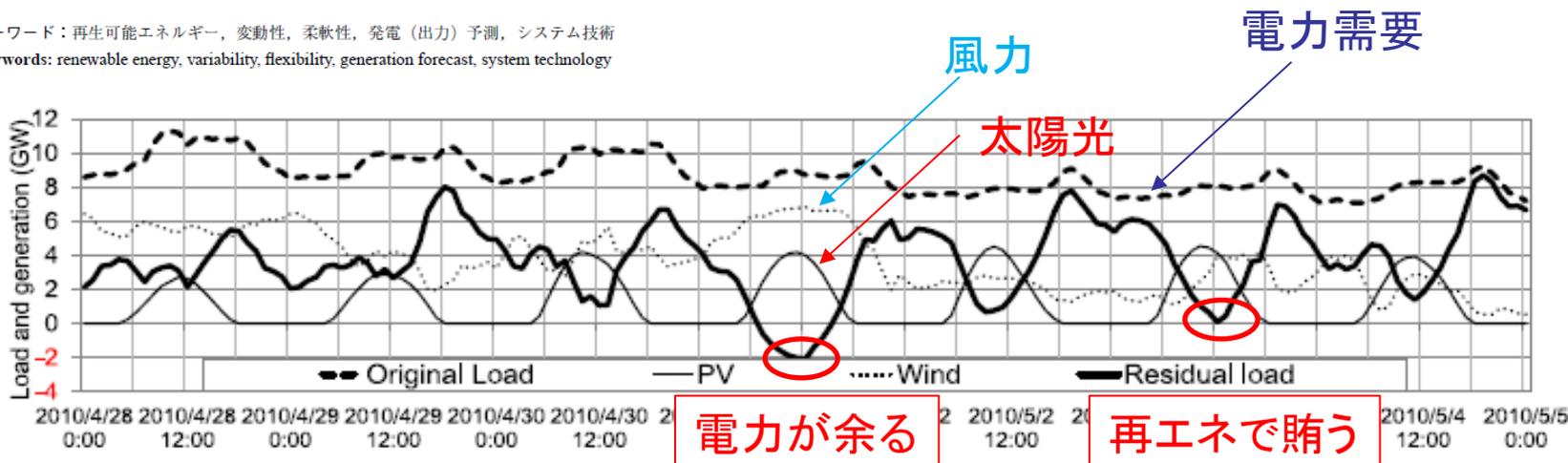


図4 最小残余需要の発生日とその前後3日間の需要・太陽光発電量・風力発電量・残余需要 (東北システム)

Fig. 4. Original load, PV and wind generation and residual load of the 7 days including the minimum residual load (in Tohoku).

荻本 (2014, 電気学会論文誌B)

2017.2.2~3
第33回エネルギーシステム
経済・環境コンファレンス
講演論文集

住宅用燃料電池の出力調整力からみた
太陽光発電出力予測誤差の評価

Evaluation of Forecast Accuracy of Photovoltaic Power Generation
by Power Output Flexibility of Residential Fuel Cell

加藤 丈佳 * 真鍋 勇介 * 栗本 宗明 ** 舟橋 俊久 *
Takeyoshi Kato Yusuke Manabe Muneaki Kurimoto Toshihisa Funabashi

An accurate and reliable forecasting of photovoltaic power generation system (PVS) is essential for effective utilization of various energy resources in demand side for the integration of PVS at high level. This paper evaluates the forecast accuracy of PV power generation in terms of flexible operation of residential fuel cell (FC). The main results are as follows. When the forecast error of 4 kW PVS is compensated by 0.7kW FC using electricity load following control, 30% of annual forecast error can be compensated. When the reverse power flow from FC system is allowed, the compensating forecast error can be increased to 60%. In the case of the forecast error of aggregated PVS, the ratio of compensating forecast error is increased by about 10%. Even when the forecast error of 20 kW PV system is compensated by 0.7 kW, 20% of annual forecast error can be compensated. These results suggests that the forecast error of PVS can be managed to a certain level by the flexible operation of residential FC.

Keywords : Photovoltaic Power Generation, Forecast, Residential Fuel Cell, Demand Side

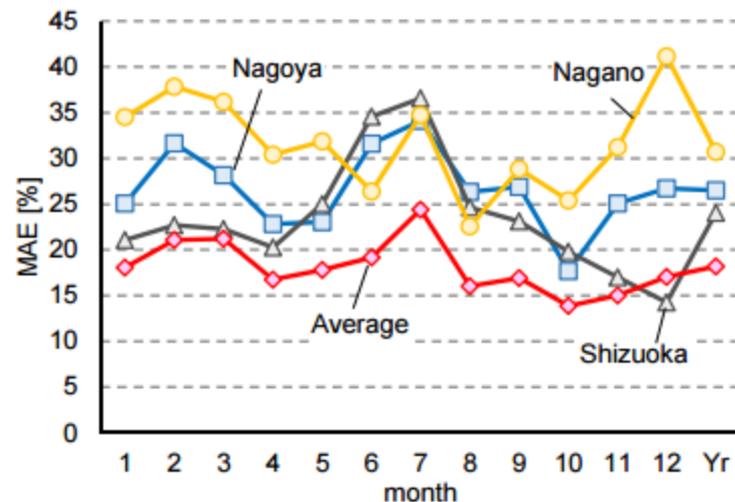
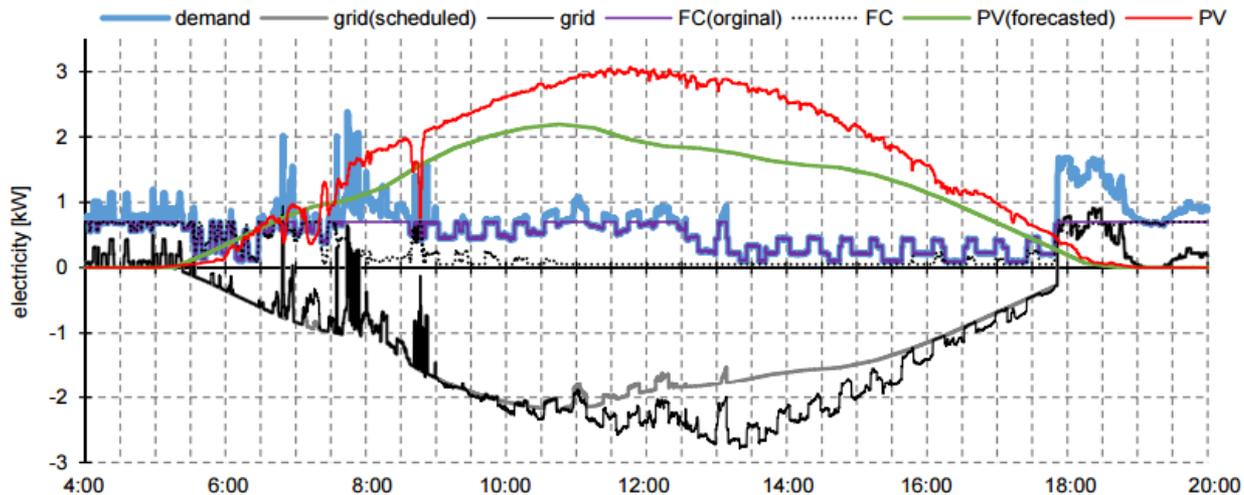


図2 日射予測誤差



(a) 2012年7月26日(木)

- 燃料電池の運用に太陽光発電予測(日射量予測)の利用

(加藤、2017、第33回エネルギーシステム 経済・環境コンファレンス講演論文集)



Improving electrical grid efficiency through weather-based dynamic-thermal-rating methods

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The University of British Columbia



Introduction

- High powerline temperatures can damage lines and are hazardous.
- Powerline temperature depends on the conductor's characteristics, the amount of electrical current in the line, and the prevailing weather conditions.
- Higher wind speeds and lower temperatures allow more power to be transmitted due to cooling effects.
- A thermal rating is the amount of current that can be in a given powerline under the prevailing weather conditions without causing damage or too much sag.
- Most companies use static thermal ratings that assume worst case weather conditions for an entire season.
- Using numerical weather prediction forecasts to forecast dynamic thermal line ratings (that change based on weather conditions) is a relatively new concept.
- Dynamic thermal ratings (DTR) are calculated using real-time or forecasted weather conditions that allow companies to take better advantage of the full transmission capacity of the lines, optimizing their system, and reducing costs.

Preliminary Results & Conclusions

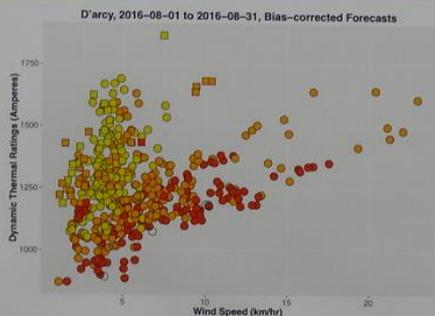


Fig. 3. DTRs calculated with bias-corrected wind speed and temperature ensemble average. DTRs plotted against wind speed, as a function of wind direction and temperature.

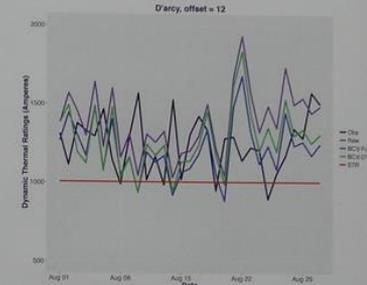


Fig. 4. DTRs calculated based on ensemble average for forecast hour 12, with weather observations (black), raw forecasts (purple), bias-corrected weather-variable forecast method (blue), and bias-corrected DTR forecast method (green), with a seasonal, static thermal rating for the powerline's region (red).

送電線



Fig. 1. High-voltage transmission lines in British Columbia.

Methodology

- DTRs are calculated using the IEEE Std. 738 for Calculating Current-Temperature of Bare Overhead Conductors, which take into account convective cooling, radiative cooling, solar heating, and resistive heating.
- Air temperature, wind speed, and wind direction forecasts from a high-resolution NWP ensemble system, and observations are used to calculate DTRs.
- Weather observations on the transmission lines are not available, so instead we use nearby weather stations to post-process and verify NWP forecasts. This simulates how accurate DTR forecasts could be if on-line weather stations were present.
- Two methods of DTR bias-correction are used: 1) DTRs are calculated with the bias-corrected wind speed and temperature forecasts, 2) DTRs are bias-corrected after being calculated with raw forecasts.

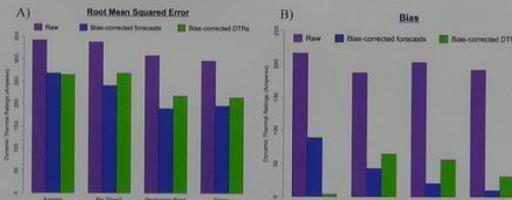


Fig. 5. Bar plot of the A) root mean squared error (RMSE), and B) bias, between DTRs calculated from observations and DTRs calculated with raw forecasts (purple), using the weather-variable-based bias correction method (blue), and using the DTR-based bias correction method (green).

- Fig. 3 shows the clear temperature - DTR relationship. Higher DTRs are associated with lower temperatures, and vice versa. Also, for higher temperatures, DTRs increase as wind speed increases.
- Fig. 3 also shows higher DTRs are associated with wind angled perpendicular to the line.
- Fig. 4 illustrates the potential for DTR forecasts to improve efficiency and safety over static ratings.
- Fig. 5 shows that both bias-correction techniques improve DTRs significantly. These preliminary results indicate that the weather-variable-based bias-correction may be superior.

Future Work



Fig. 2. Approximate location of the 360 kV transmission line (yellow), weather stations used surrounding the line (red).

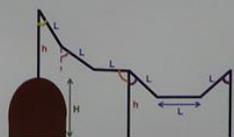


Fig. 6. Diagram of powerline segments split into three angled sections to approximate the catenary shape of the hanging powerline. The angles between the powerline and the towers are different depending if the two supporting towers are at the same elevation or not.

- Include precipitation and evaporative cooling effects with the IEEE equations.
- Account for topographic effects and the catenary shape of the line on the incident angle of incoming solar radiation (Fig. 6).
- Calculate DTRs at every point along the transmission line.
- Create graphical display showing continuously varying DTR along line, based on high resolution gridded NWP output.
- Compare DTRs with static line ratings and quasi-DTRs.
- **Primary Goal:** Probabilistically calibrate the DTR forecasts to produce forecasted probability of exceedance forecasts for a given line temperature threshold for different currents.

IEEE, Standard for calculating the current-temperature of bare overhead conductors. IEEE Std 738; 2012.

送電線の運用に数値予報のアンサンブル情報を利用。(24時間先までの予測を活用)

・再エネの電力→送電線の加熱率(heating rate)に影響を与える。通常は電力は安定供給だが、再エネが入ると変動有り

・送電線の研究では24時間先まで送電事業者に情報を送付

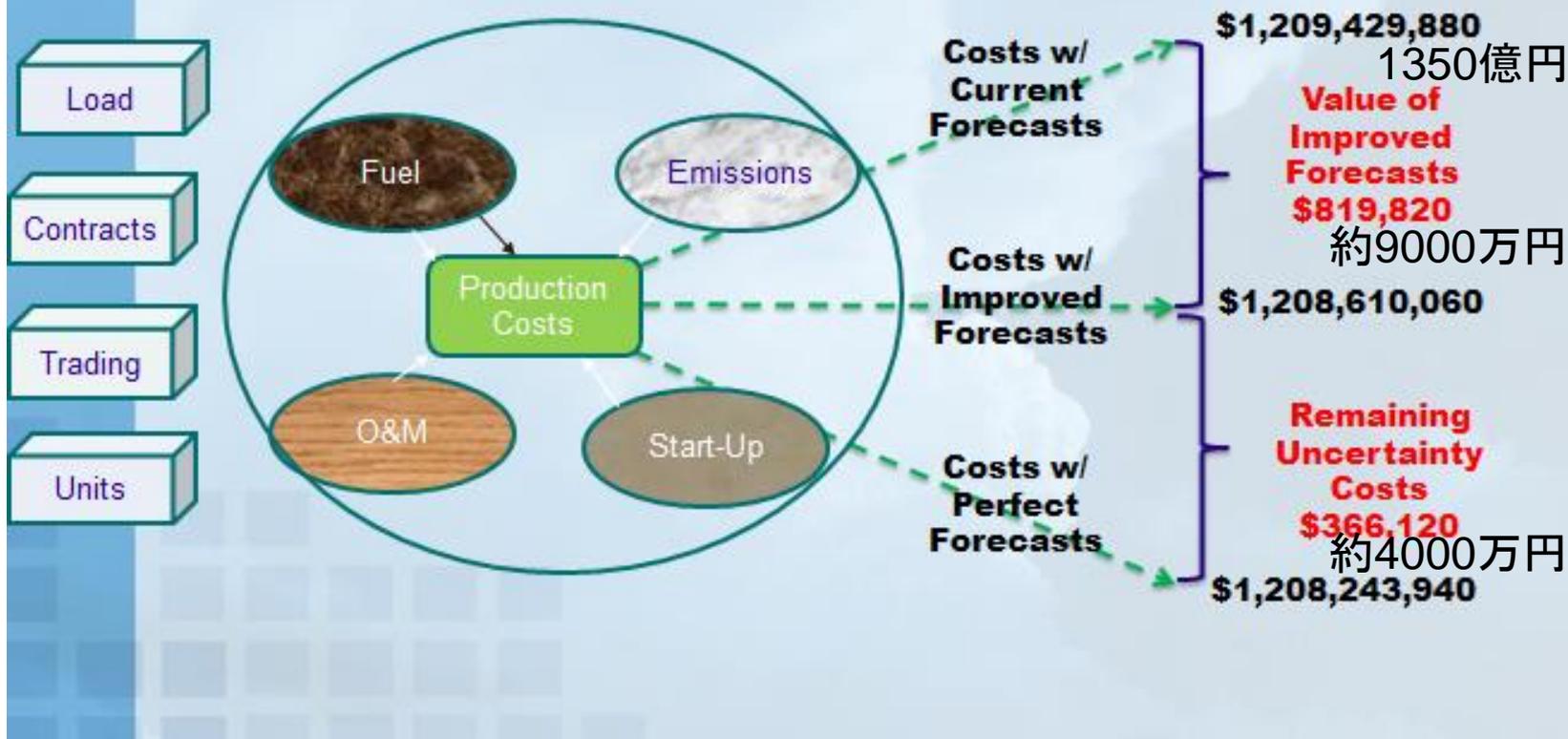
・1日先までを対象

・アンサンブル平均を活用、個別のメンバーもいろいろなシナリオを考えるために利用。アンサンブルメンバーは37個。

Conceptual Model of Production Costs



将来推計: 2024年における1.8GWの太陽光発電設備導入を想定(米・コロラド州)



AMS2017年次大会での講演資料

Courtesy of Jeffrey K. Lazo (NCAR)

発表中の降灰予報(速報・詳細)

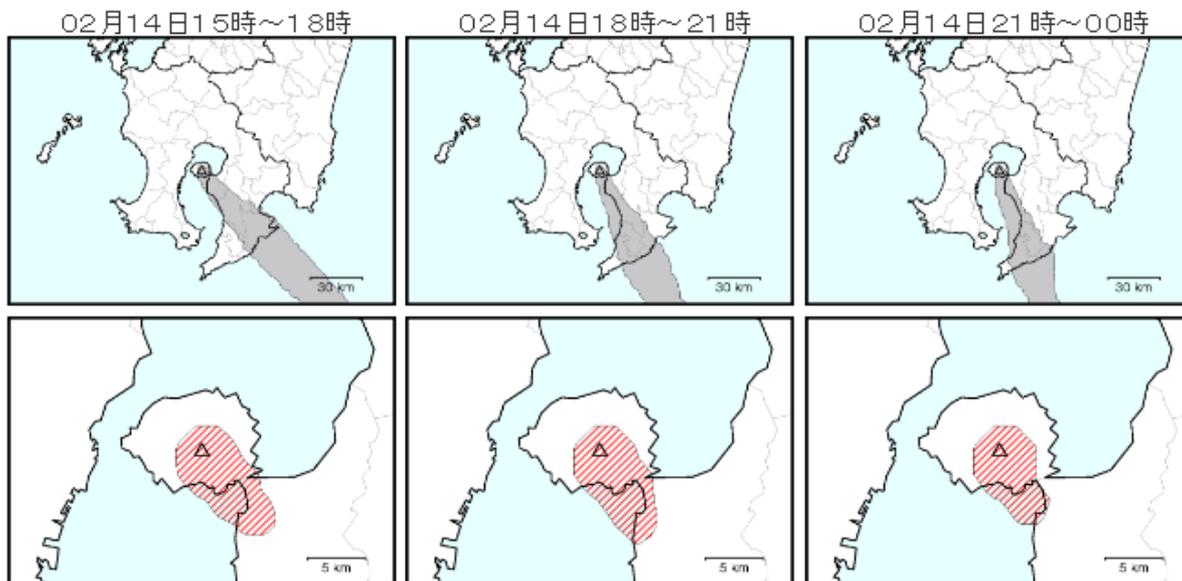
現在、発表中の降灰予報はありません

降灰予報(定時)

最新の降灰予報(定時)図情報のうち、はじめの9時間分の子測図を表示しています。
火山選択により、対象火山を切り替えられます。

火山選択

○ : 降灰の範囲
 : 小さな噴石の落下範囲



気象庁:降灰予報の発表状況

<http://www.data.jma.go.jp/svd/vois/data/kouhai/jishin/ashfall.html>

気象庁では降灰予報も実施

太陽電池の保守や運用・管理の分野にも、このような予測情報の活用も期待。

- 再生可能エネルギー分野では自然エネルギーなだけに気象データの活用は必須
- しかし、エネルギー分野(電力需給、需要家、送電分野など分野は広い)と気象分野との交流がまだ乏しいのが現状
- **問題点の整理** → どのような地球科学データ(観測・予測)があって、どこに応用できるか**ニーズの抽出**
- 人・意見・データの交流 → 課題解決に向けて(**予測誤差**はユーザの利用用途によっては、**予測が使えるものとそうでないものがあるため**、提供側は気にする必要はない。より精度の良い予測データを)

本研究はJST CREST「太陽光発電の予測不確実性を許容する超大規模電力最適配分制御」の中において実施されています。