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アジア/世界エネルギーアウトルック2014
気候変動の観点からのコメントと エネ研への期待

山口光恒
東京大学・RITE

評価すべき点

- 世界及びアジアのエネルギー全体の総合的観点に基づく気候変動問題の分析
- 技術進展ケースの内容などエネ研の強み
- 2℃目標達成の濃度として450ppmCO2eのみならず500ppmCO2eも含めて考える点
- 適応を含めた効率的・効果的対策の必要性の指摘は特筆に値する

消えた世界半減目標 overshoot scenarioの出現

AR4　2℃実現には2050年の世界排出量を2000年比半減

Table SPM.5: *Characteristics of post-TAR stabilization scenarios [Table TS 2, 3.10][a)]*

Category	Radiative forcing (W/m^2)	CO_2 concentration[c)] (ppm)	CO_2-eq concentration[c)] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b), c)] (°C)	Peaking year for CO_2 emissions[d)]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d)]
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30

AR5　2℃実現には2050年の世界排出量を2010年比72～41%削減

CO_2eq Concentrations in 2100 (CO_2eq) Category label (concentration range)[9]	Subcategories	Relative position of the RCPs[5]	Cumulative CO_2 emission[3] ($GtCO_2$)		Change in CO_2eq emissions compared to 2010 in (%)[4]		
			2011–2050	2011–2100	2050	2100	2100 Temperature change (°C)[7]
< 430	*Only a limited number of individual model studies have explored levels belo*						
450 (430–480)	Total range [1,10]	*RCP2.6*	550–1300	630–1180	-72 to -41	-118 to -78	1.5–1.7 (1.0–2.8)
500 (480–530)	No overshoot of 530 ppm CO_2eq		860–1180	960–1430	-57 to -42	-107 to -73	1.7–1.9 (1.2–2.9)
	Overshoot of 530 ppm CO_2eq		1130–1530	990–1550	-55 to -25	-114 to -90	1.8–2.0 (1.2–3.3)

2010年比72～41%削減＝2000年比66～28%削減
同上　25～57%削減＝　同上　47～ 8%削減

不確実性問題　気候感度

- TAR 1.5-4.5 (2.5)℃、AR4 2-4.5 (3)℃、AR5 1.5-4.5℃
- AR5/WG1の気候感度変更と最尤推定値無しの情報はWG3では全く触れられていない
- 気温で目標を決めることは不可能

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The Global Warming Statistical Meltdown

By Judith Curry

At the recent United Nations Climate Summit, Secretary-General Ban Ki-moon warned that "Without significant cuts in emissions by all countries, and in key sectors, the window of opportunity to stay within less than 2 degrees [of warming] will soon close forever." Actually, this window of opportunity may remain open for quite some time. A growing body of evidence suggests that the climate is less sensitive to increases in carbon-dioxide emissions than policy makers generally assume—and that the need for reductions in such emissions is less urgent.

According to the U.N. Framework Convention on Climate Change, preventing "dangerous human interference" with the climate is defined, rather arbitrarily, as limiting warming to no more than 2 degrees Celsius (3.6 degrees Fahrenheit) above preindustrial temperatures. The Earth's surface temperatures have already warmed about 0.8 degrees Celsius since 1850-1900. This leaves 1.2 degrees Celsius (about 2.2 degrees Fahrenheit) to go.

In its most optimistic projections, which assume a substantial decline in emissions, the Intergovernmental Panel on Climate Change (IPCC) projects that the "dangerous" level might never be reached. In its most extreme, pessimistic projections, which assume heavy use of coal and rapid population growth, the threshold could be exceeded as early as 2040. But these projections reflect the effects of rising emissions on temperatures simulated by climate models, which are being challenged by recent observations.

Human-caused warming depends not only on increases in greenhouse gases but also on how "sensitive" the climate is to these increases. Climate sensitivity is defined as the global surface warming that occurs when the concentration of carbon dioxide in the atmosphere doubles. If climate sensitivity is high, then we can expect substantial warming in the coming century as emissions continue to increase. If climate sensitivity is low, then future warming will be substantially lower, and it may be several generations before we reach what the U.N. considers a dangerous level, even with high emissions.

The IPCC's latest report (published in 2013) concluded that the actual change in 70 years if carbon-dioxide concentrations double, called the transient climate response, is likely in the range of 1 to 2.5 degrees Celsius. Most climate models have transient climate response values exceeding 1.8 degrees Celsius. But the IPCC report notes the substantial discrepancy between recent observation-based estimates of climate sensitivity and estimates from climate models.

Nicholas Lewis and I have just published a study in Climate Dynamics that shows the best estimate for transient climate response is 1.33 degrees Celsius with a likely range of 1.05-1.80 degrees Celsius. Using an observation-based energy-balance approach, our calculations used the same data for the effects on the Earth's energy balance of changes in greenhouse gases, aerosols and other drivers of climate change given by the IPCC's latest report.

Mounting evidence suggests that basic assumptions about climate change are mistaken: The numbers don't add up.

We also estimated what the long-term warming from a doubling of carbon-dioxide concentrations would be, once the deep ocean had warmed up. Our estimates of sensitivity, both over a 70-year time-frame and long term, are far lower than the average values of sensitivity determined from global climate models that are used for warming projections. Also our ranges are narrower, with far lower upper limits than reported by the IPCC's latest report. Even our upper limits lie below the average values of climate models.

Our paper is not an outlier. More than a dozen other observation-based studies have found climate sensitivity values lower than those determined using global climate models, including recent papers published in Environmentrics (2012), Nature Geoscience (2013) and Earth Systems Dynamics (2014). These new climate sensitivity estimates add to the growing evidence that climate models are running "too hot." Moreover, the estimates in these empirical studies are being borne out by the much-discussed "pause" or "hiatus" in global warming—the period since 1998 during which global average surface temperatures have not significantly increased.

This pause in warming is at odds with the 2007 IPCC report, which expected warming to increase at a rate of 0.2 degrees Celsius per decade in the early 21st century. The warming hiatus, combined with assessments that the climate-model sensitivities are too high, raises serious questions as to whether the climate-model projections of 21st-century temperatures are fit for making public-policy decisions.

The sensitivity of the climate to increasing concentrations of carbon dioxide is a central question in the debate on the appropriate policy response to increasing carbon dioxide in the atmosphere. Climate sensitivity and estimates of its uncertainty are key inputs into the economic models that drive cost-benefit analyses and estimates of the social cost of carbon.

Continuing to rely on climate-model warming projections based on high, model-derived values of climate sensitivity skews the cost-benefit analyses and estimates of the social cost of carbon. This can bias policy decisions. The implications of the lower values of climate sensitivity in our paper, as well as similar other recent studies, is that human-caused warming near the end of the 21st century should be less than the 2-degrees-Celsius "danger" level for all but the IPCC's most extreme emission scenario.

This slower rate of warming—relative to climate model projections—means there is less urgency to phase out greenhouse gas emissions now, and more time to find ways to decarbonize the economy affordably. It also allows us the flexibility to revise our policies as further information becomes available.

Ms. Curry, a professor and former chairwoman of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology, is the president of Climate Forecast Applications Network.

仮に2℃目標としても

Observation basedの研究

気候感度は1.25-2.45℃、最尤推定値1.64℃

Nicholas Lewis · Judith A. Curry, "The implications for climate sensitivity of AR5 forcing and heat uptake estimates" Climate Dynamics, 2014

なぜ2℃なのか

温暖化交渉行き詰まりの最大の原因

- 2℃がdangerousとsafeの分岐点？
  この点について世界で詰めた議論なし
- 2℃目標の科学的根拠

  William Nordhaus “The Climate Casino, Risk, Uncertainty, and Economics for a Warming World”, Yale University Press 2013

  The surprising answer is that the scientific rationale for the 2 ℃ target is not really very scientific. ---- So the politicians refer to the science, and the scientists refer to the politics (p. 200)
- この点についての議論を期待

再エネの最適導入量（スライド18）

- 間欠性を有する再エネのIntegration cost、CO2価格を考慮した最適導入量の研究
- ドイツの風力の例

Falko Ueckerdt , Lion Hirth , Gunnar Luderer, Ottmar Edenhofer, “System LCOE: What are the costs of variable renewables?”, Energy 63 (2013)

- エネルギー安全保障との関係

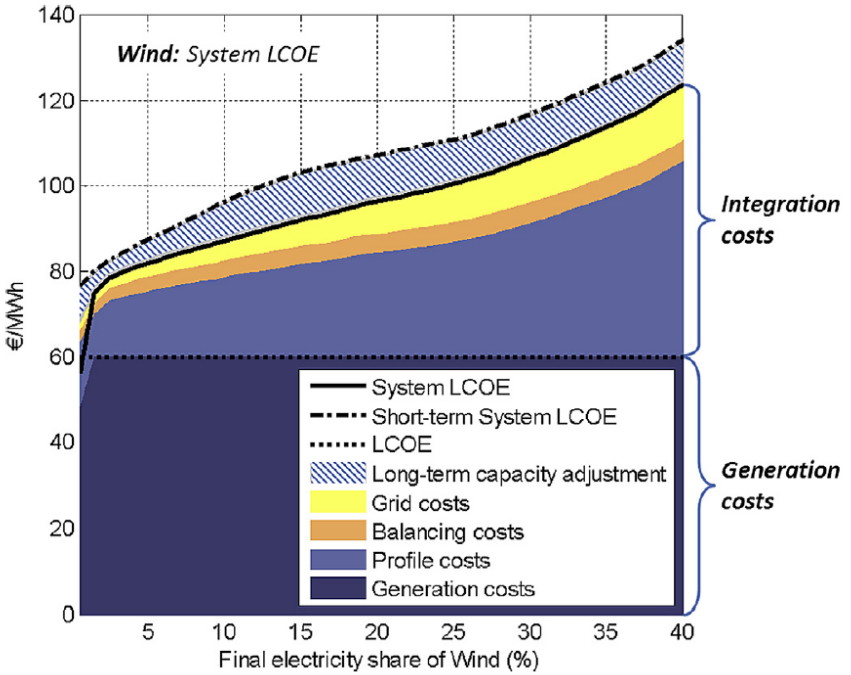

Fig. 9. System LCOE for increasing shares of wind representing typical thermal power systems in Europe. Integration costs rise up to the order of magnitude of generation costs. Integration costs can thus become an economic barrier to large deployment of VRE.

お問い合わせ: report@tky.ieej.or.jp