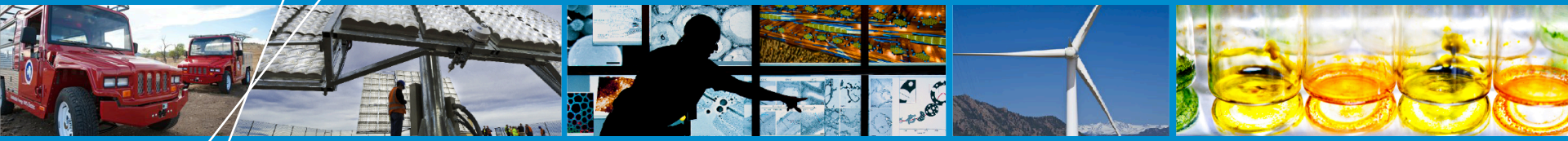
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

IAM Crosscut: Resource Scenarios



2013 CCI/IA Workshop
July 22, 2013

Patrick Sullivan

Renewables Initiative Scenarios

Objective: explore models' responsiveness—especially in wind deployment—to changes in different model inputs/ assumptions in a few dimensions:

- **Wind Resource (quantity and cost)**
- **Competition (availability of nuclear and CCS for mitigation, presence of carbon signal)**
- **Integration of VRREs (e.g., backup requirement)**

Renewables Initiative Scenarios

		Wind Resource	Wind Cost	Carbon Policy	Integration Cost/Limit	Nuke/CCS Availability
Mandatory	1. Flagship	Model's existing supply curve	Standard	Tax	Standard	All tech
	2. New Wind	**NREL supply curve, new**	Standard	Tax	Standard	All tech
	3. No Policy	Model's existing supply curve	Standard	**None**	Standard	All tech
	4. RE	Model's existing supply curve	Standard	Tax	Standard	**Nuke phase-out, no CCS**
	5. Generous RE Integration	Model's existing supply curve	Standard	Tax	**Relaxed**	All tech
	6. Strict RE Integration	Model's existing supply curve	Standard	Tax	**Tightened**	All tech
Optional	7. Low Cost	Model's existing supply curve	**Low**	Tax	Standard	All tech
	8. High Cost	Model's existing supply curve	**High**	Tax	Standard	All tech
	9. Low Resource	**Model's existing supply curve, low**	Standard	Tax	Standard	All tech
	10. High Resource	**Model's existing supply c., high**	Standard	Tax	Standard	All tech
	11. Climate Policy	Model's existing supply curve	Standard	**550**	Standard	All tech
	12. Flip Offshore	**NREL s.c., new, +/- offshore**	Standard	Tax	Standard	All tech

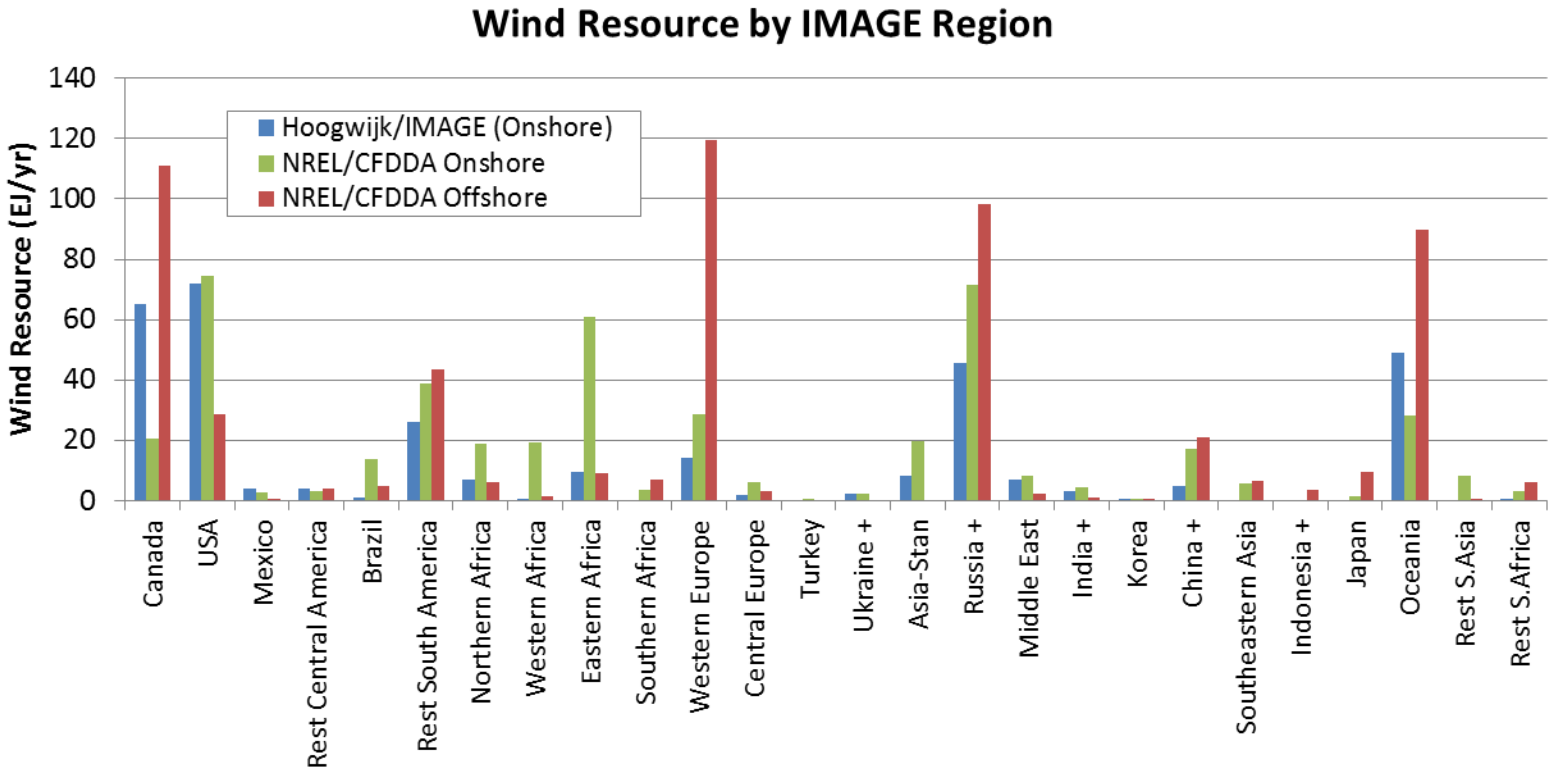
NREL/CFDDA Resource Assessment

Increased resource compared to Hoogwijk et al. (2004) assessment used by IMAGE and other models.

Global Hoogwijk Resource < 103 $/MWh: 330 EJ/yr

NREL/CFDDA Onshore >26% nCF near and mid, >30% far: 464 EJ/yr

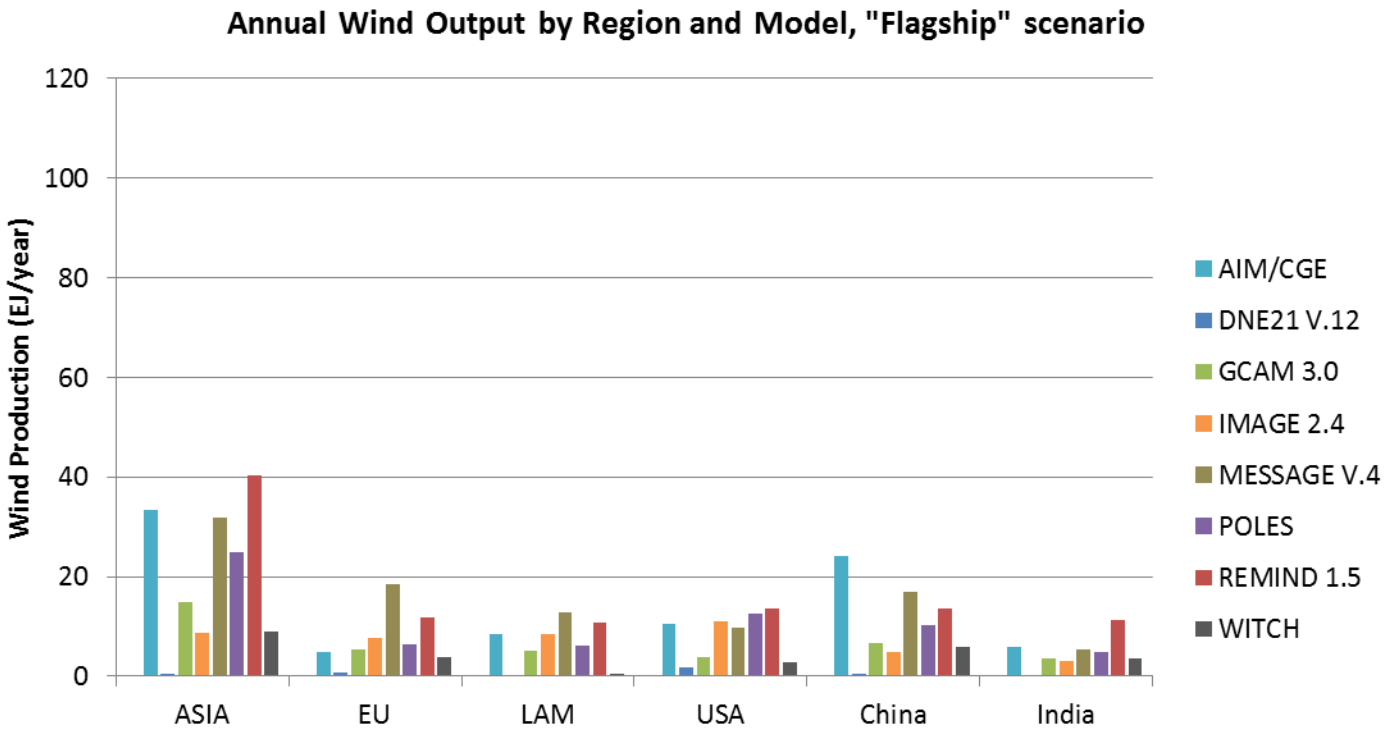
NREL/CFDDA Offshore >30% nCF near and mid, >34% far: 581 EJ/yr



Flagship Scenario Wind Production

Max wind output across model years (usually but not always final year).

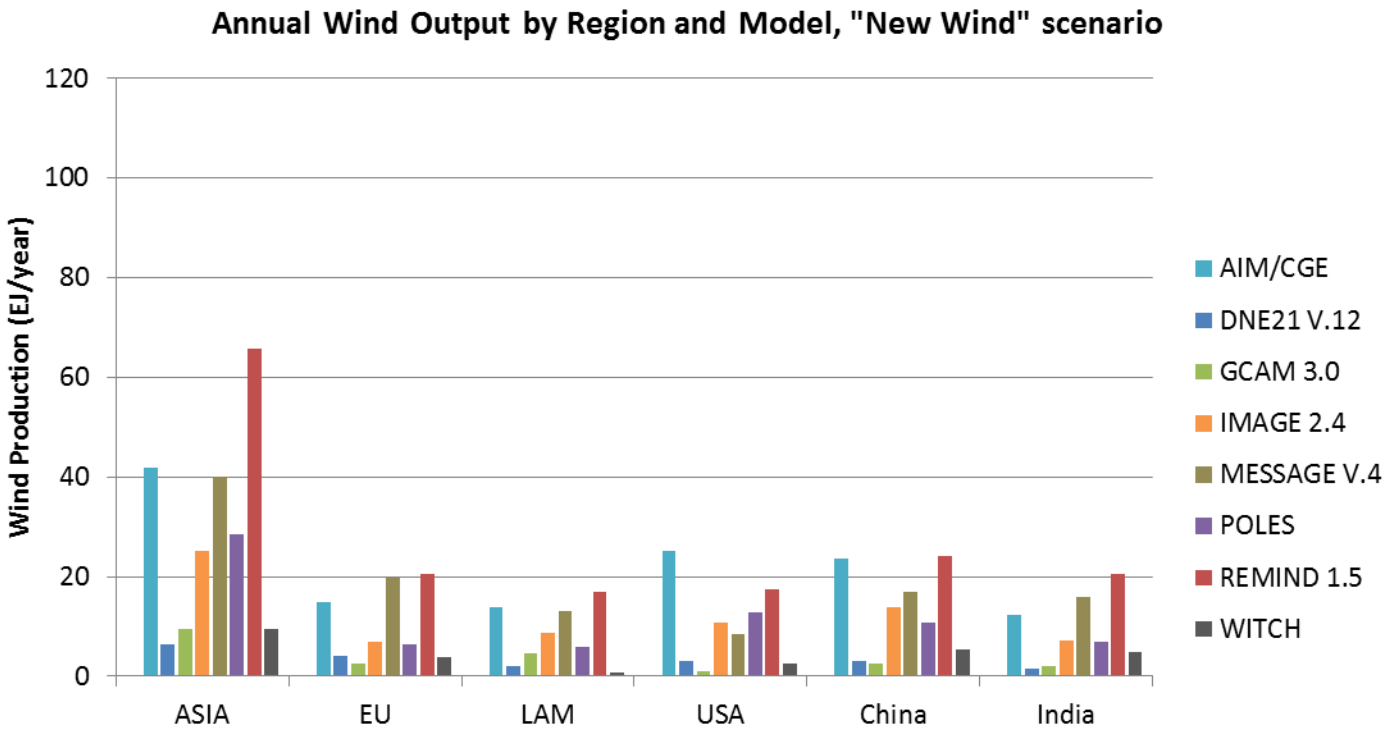
Flagship resource inputs are the models' standard.



New Wind Scenario Wind Production

There is a general increase in wind production in the New Wind scenarios over the Flagship.

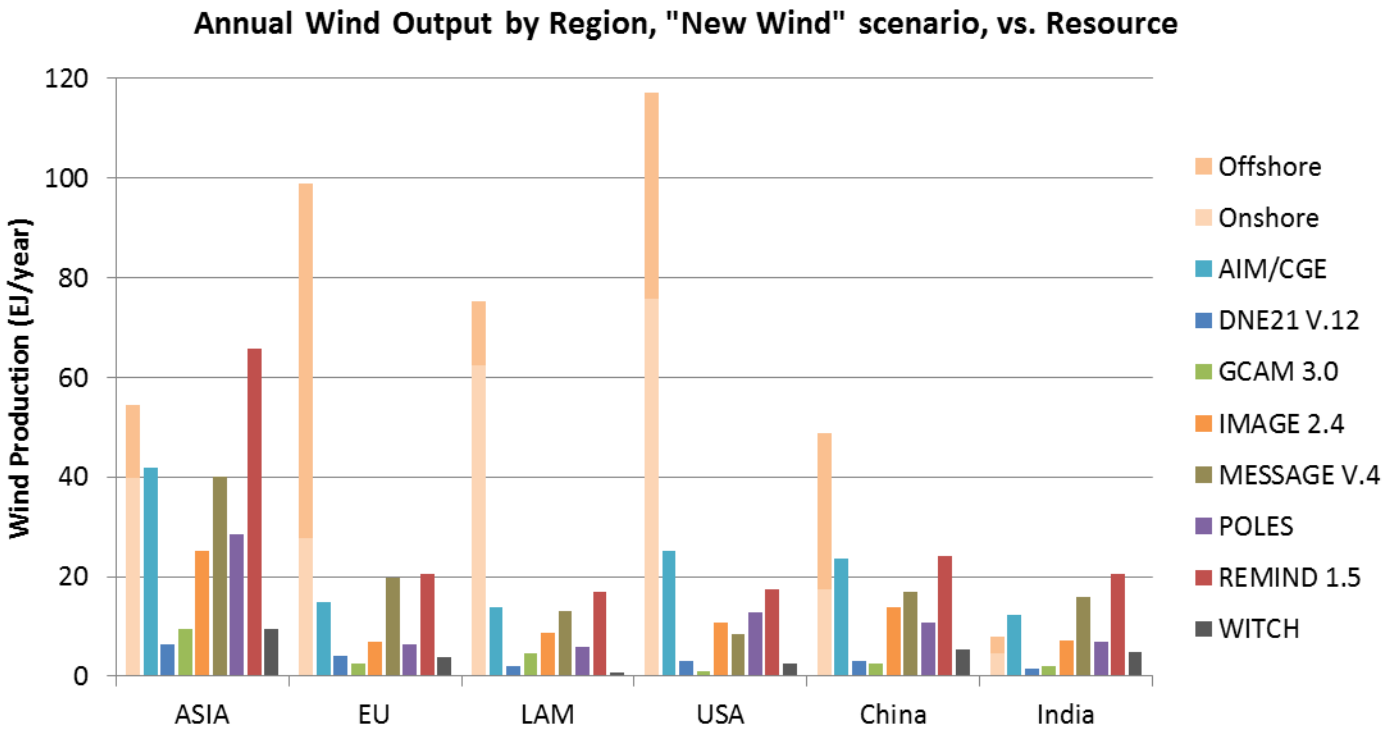
GCAM (green) declines from Flagship.



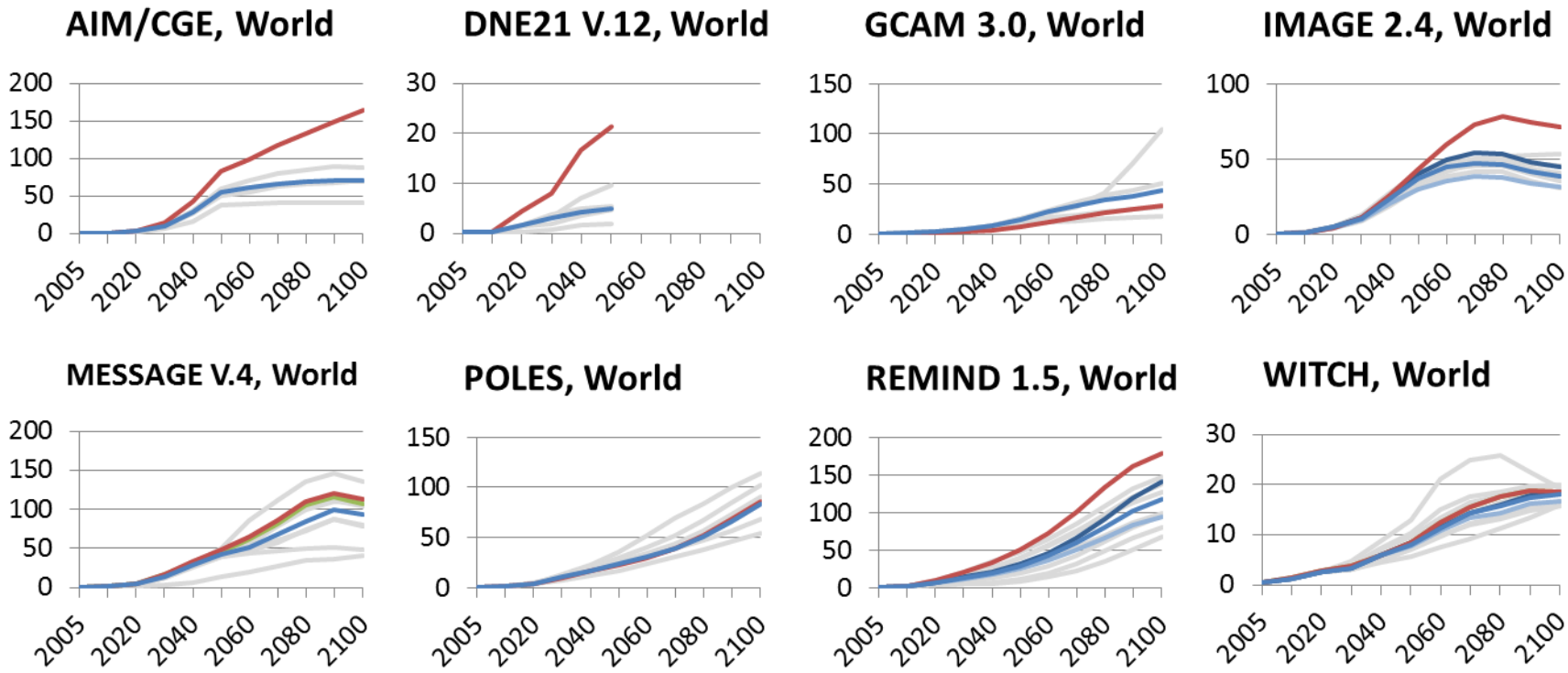
New Wind Scenario Wind Production

Resource portrayed is NREL/CFDDA resource with nCF > 26%.

There is uneven use of resource across models and regions: low-quality resource developed in India in several models.



Annual Wind Output



GCAM is the outlier in showing more wind development in the Flagship.

POLES and WITCH are the least sensitive to resource changes: interestingly, they are at very different levels of deployment.

GCAM base resource is greater

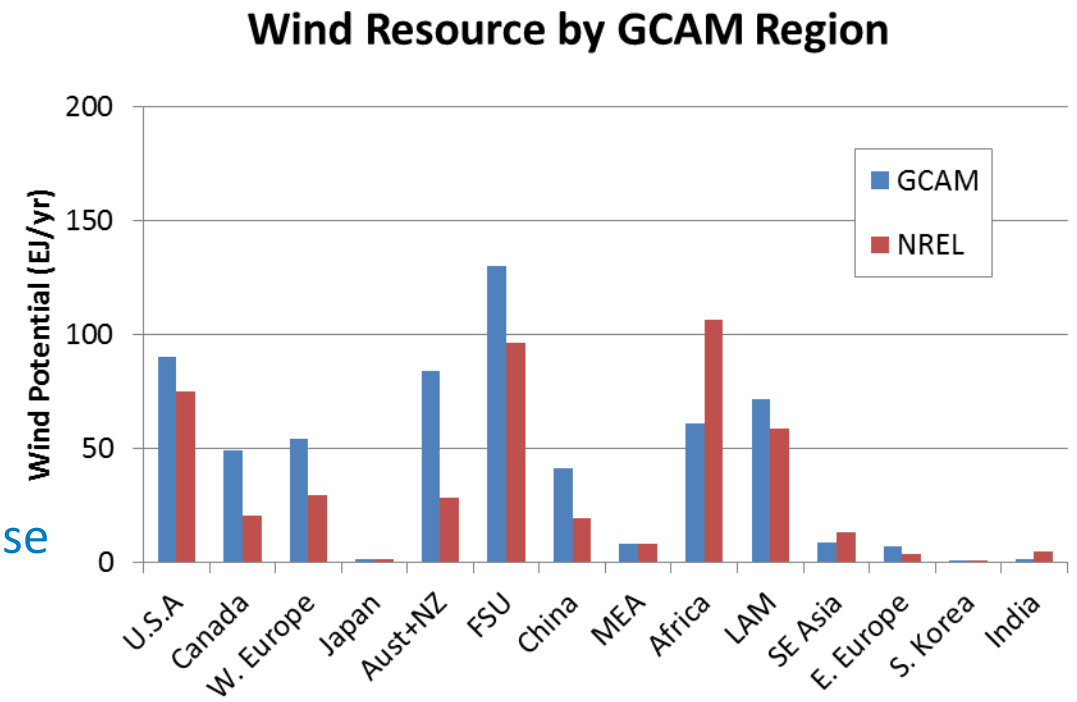
Comparison of GCAM resource available for <103 $/MWh to estimated comparable NREL/ CFDDA resource.

Zhou writes “a [gross] capacity factor of 30% is equal to a generation cost of 11 cents/ kWh.”

For NREL/CFDDA comparison, use nCF>26% for near and mid distance to transmission, nCF>30% for far.

Global total:

GCAM 606 EJ/yr
NREL 464 EJ/yr



Zhou, Y., Luckow, P., Smith, S. J., & Clarke, L. (2012). Evaluation of global onshore wind energy potential and generation costs. *Environmental science & technology*, *46*(14), 7857-7864.

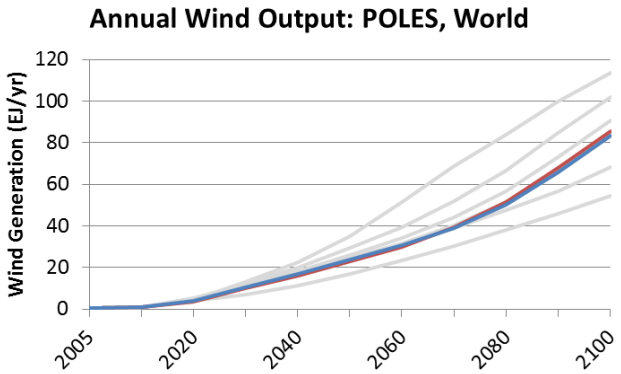
POLES is not resource-constrained

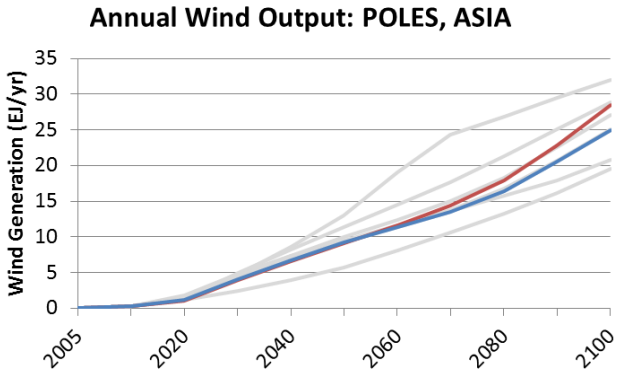
Poles has ~average wind deployment compared to other models

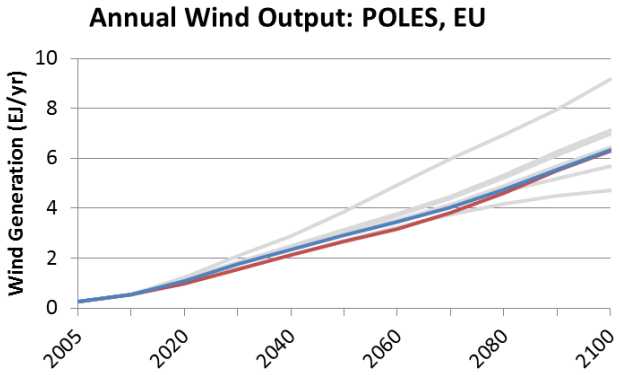
Across regions, POLES does not appreciably change wind deployment based on resource assessment.

(I regret that I do not have a comparison to POLES base resource assumptions.)

Level of economic competition with other technologies does effect deployment (Nico's talk tomorrow).





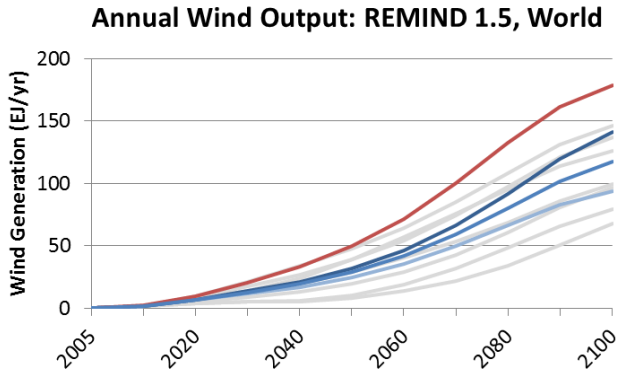


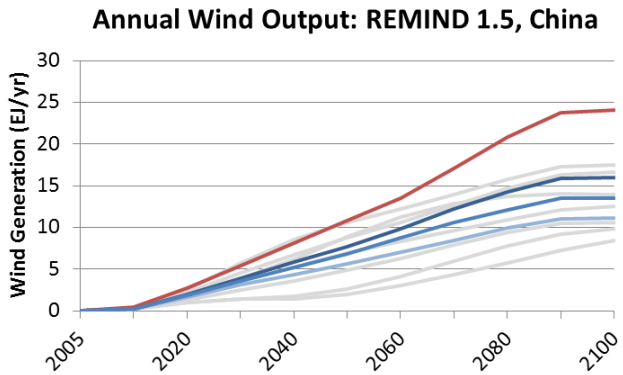
REMIND cares about resource

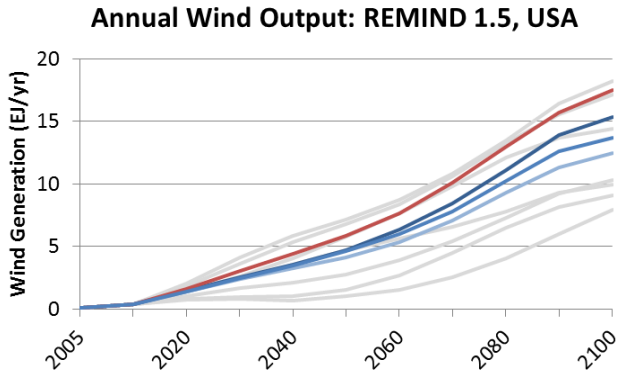
Resource assumptions are one of REMIND's largest drivers

New Wind scenario has highest wind deployment in several regions. High/ Low Resource scenarios also diverge from Flagship.

2100 wind production 118 EJ/yr in Flagship, 178 EJ/yr in New Wind







More Resource in India

Several models showed substantial increases in wind production in India using the NREL/CFDDA supply curves.

MESSAGE results imply that offshore resource may be an important component of the increase.