



International Institute for
Applied Systems Analysis
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science for global insight

Comments on Modeling Uncertainty Project (MUP)

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Yale Modeling Under Uncertainty Project

Snowmass – 27 July 2015



IIASA, International Institute for Applied Systems Analysis

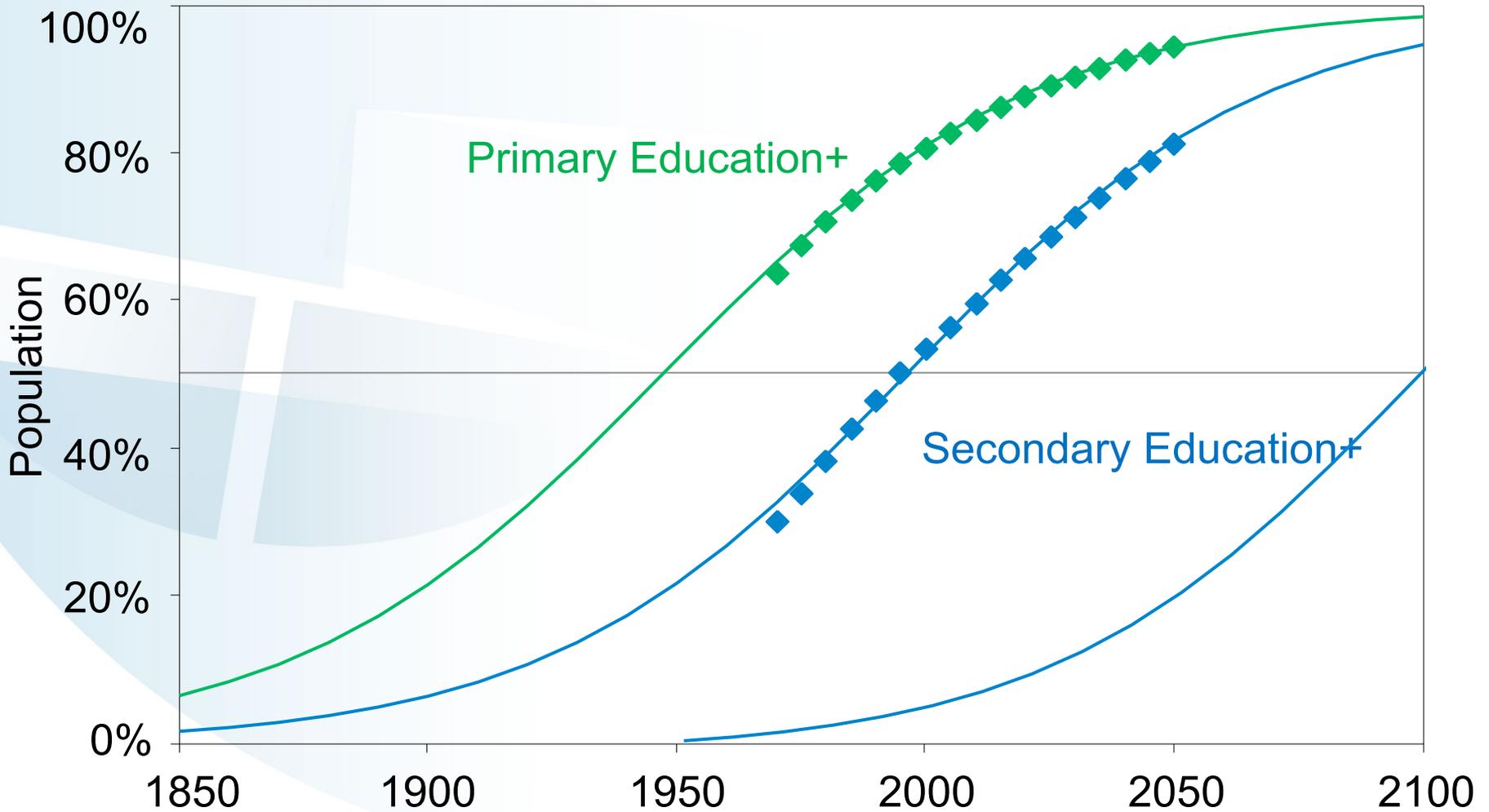
- “Uncertainty is pervasive in (the economics of) climate change and yet is poorly quantified and interpreted
- It is wrought with deep uncertainties and there are both known and almost certainly important unknown unknowns (Granger Morgan, Snowmass)
- Human intentionality is a major uncertainty influencing both parameters and structure
- Project essential for IAMs and understanding deep uncertainties of climate change

Modeling Uncertainty Project (MUP)

- Much greater parametric than structural uncertainties across all models
- Economic variables and damage function higher uncertainty than climate variables
- Similar projections of baseline parameters, diverging in alternative cases (high levels)
- Distributions of key outputs very similar, e.g. quantiles vary by less than $\frac{1}{2}^{\circ}\text{C}$
- Doubling all uncertainties results in almost doubling of the output uncertainties
- Little evidence for “fat” tails of outputs

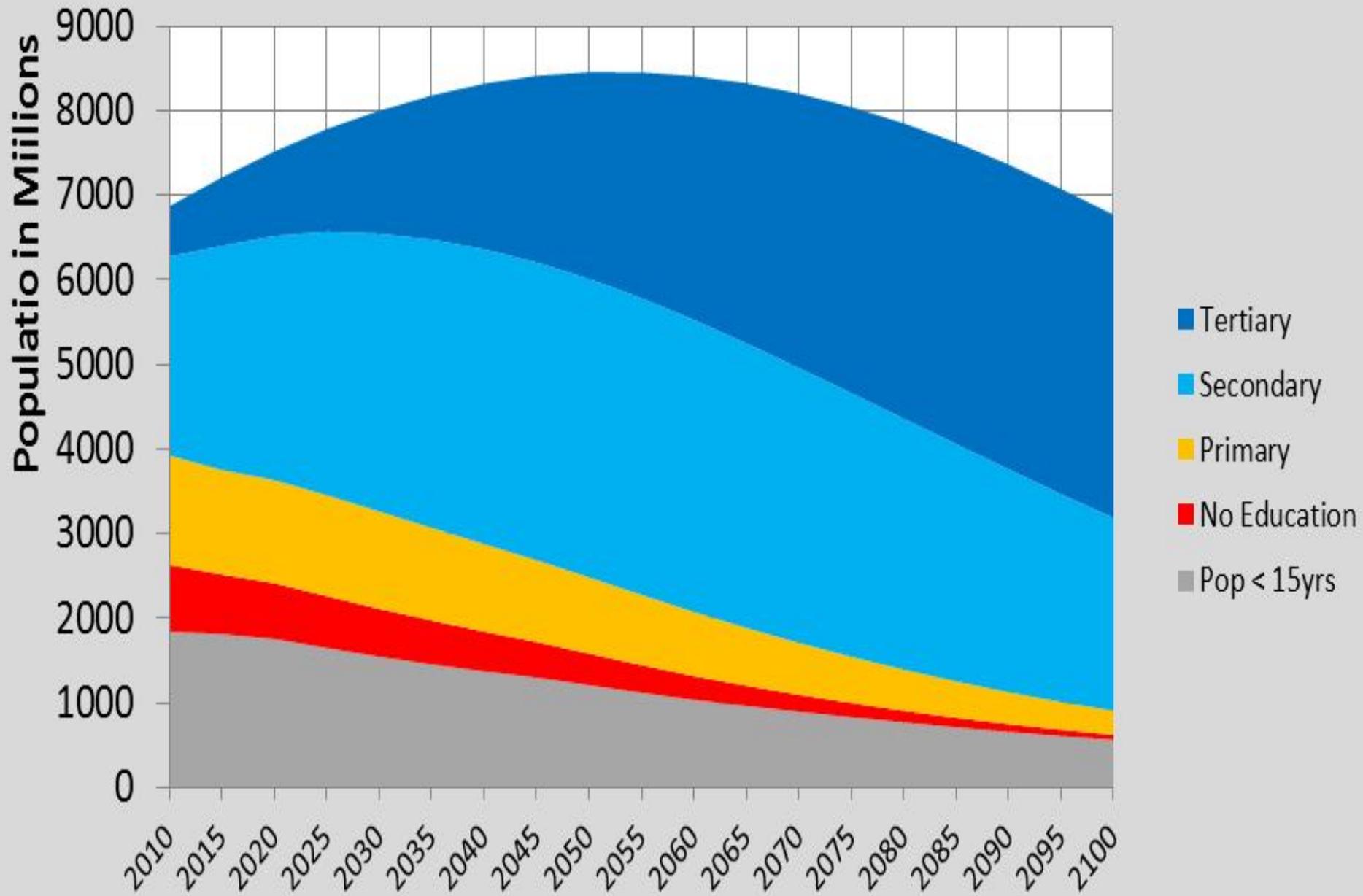
- Much greater parametric than structural uncertainties across all models
- All models are “top-down” macroeconomic approaches; other approaches would likely increase the structural uncertainties, but make comparisons much more difficult
- More detailed human capacity and technological learning could lead to richer structural variability and diversity
- Human capacity has is important for **productivity, environmental awareness, etc.**

Global Educational Attainment

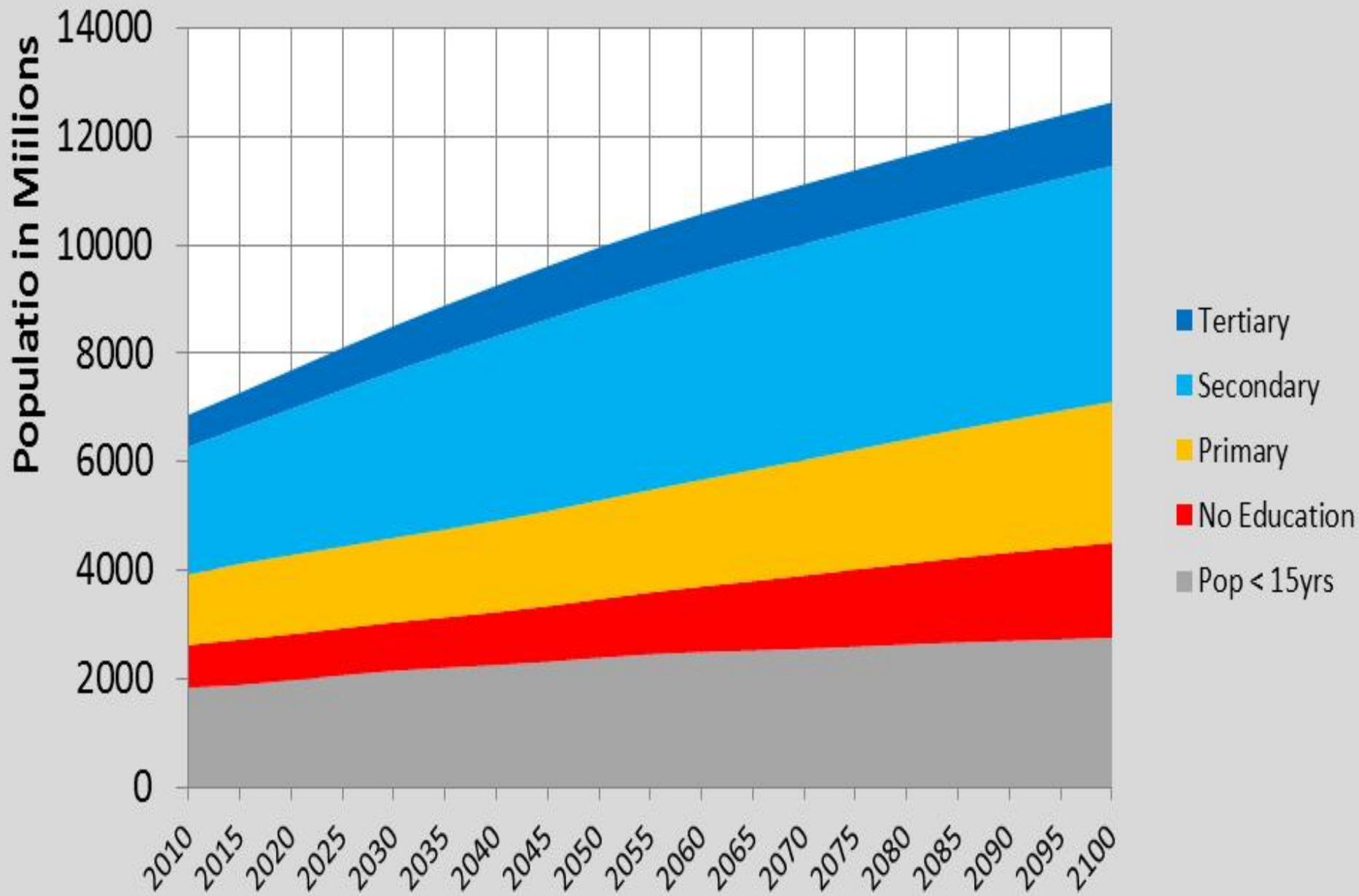


Source: Lutz et al., 2007

World SSP1



World SSP3



Shared Socioeconomic Pathway (SSP) Scenarios:

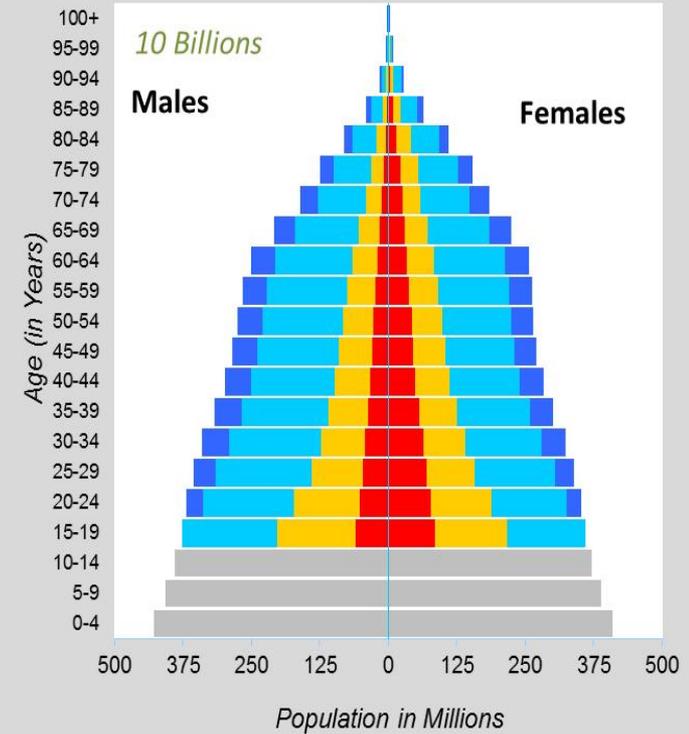
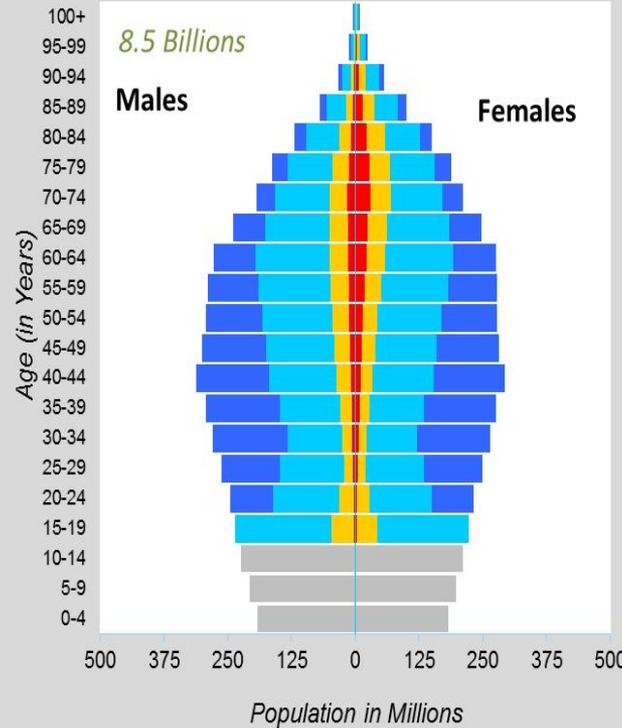
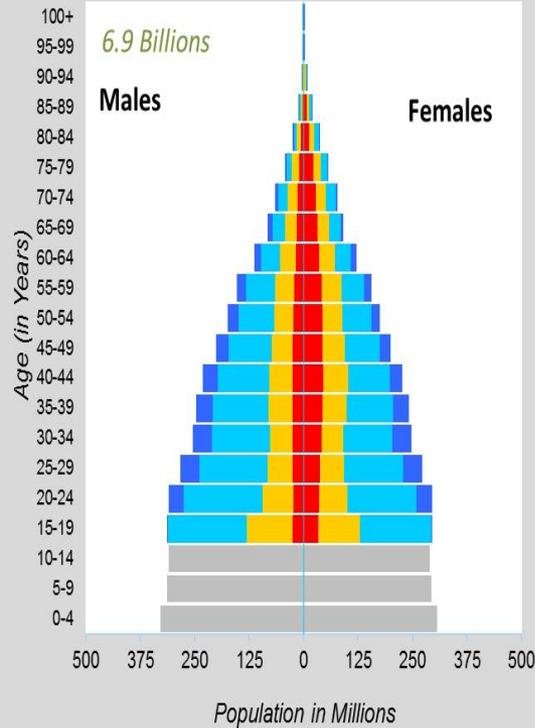
SSP1: Rapid Development

SSP3: Stalled Development

World - 2010

World - 2050 SSP1

World - 2050 SSP3



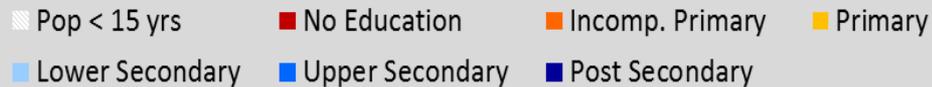
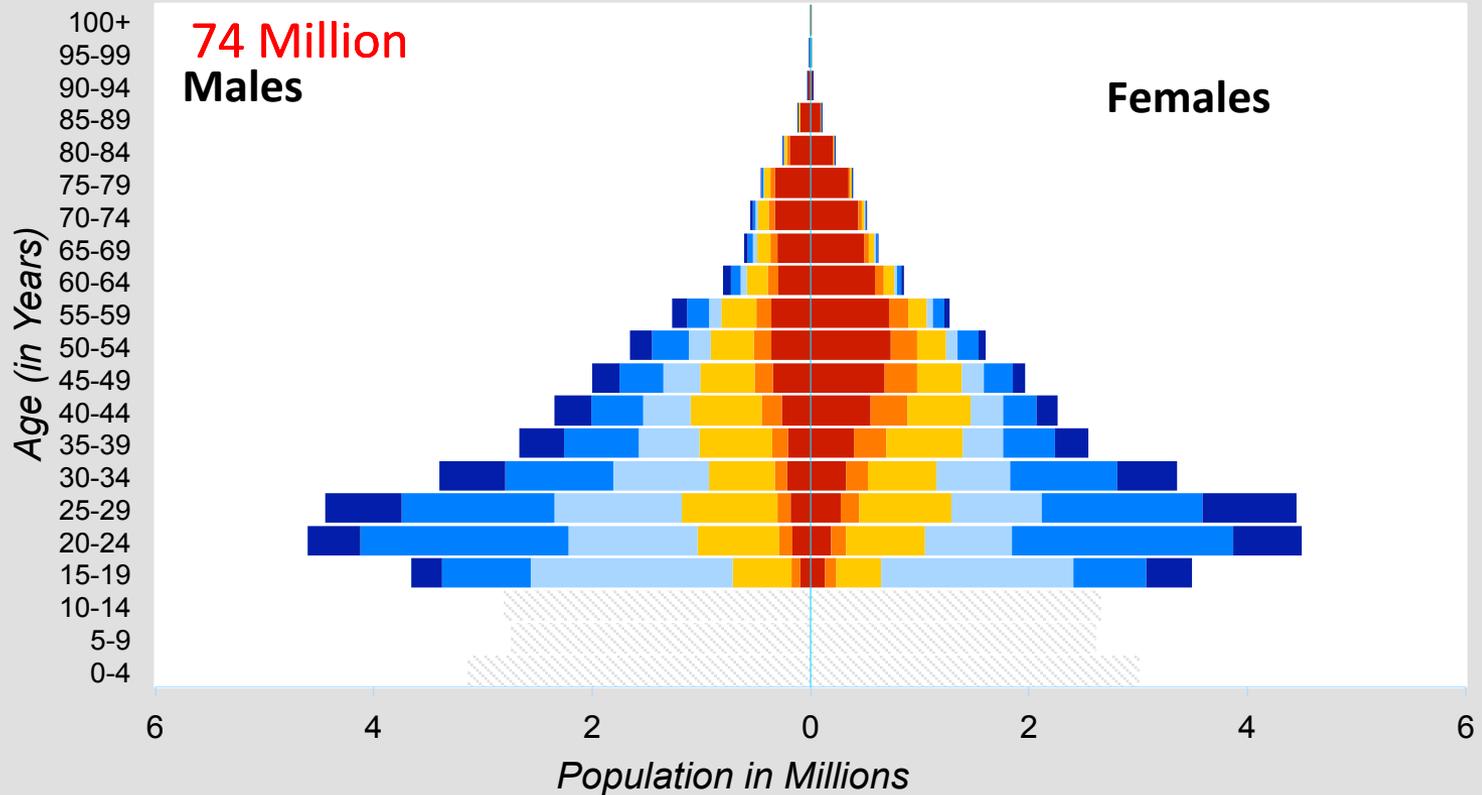
■ No Education ■ Primary ■ Secondary ■ Tertiary

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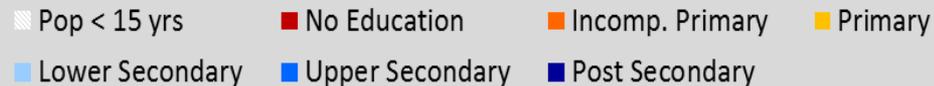
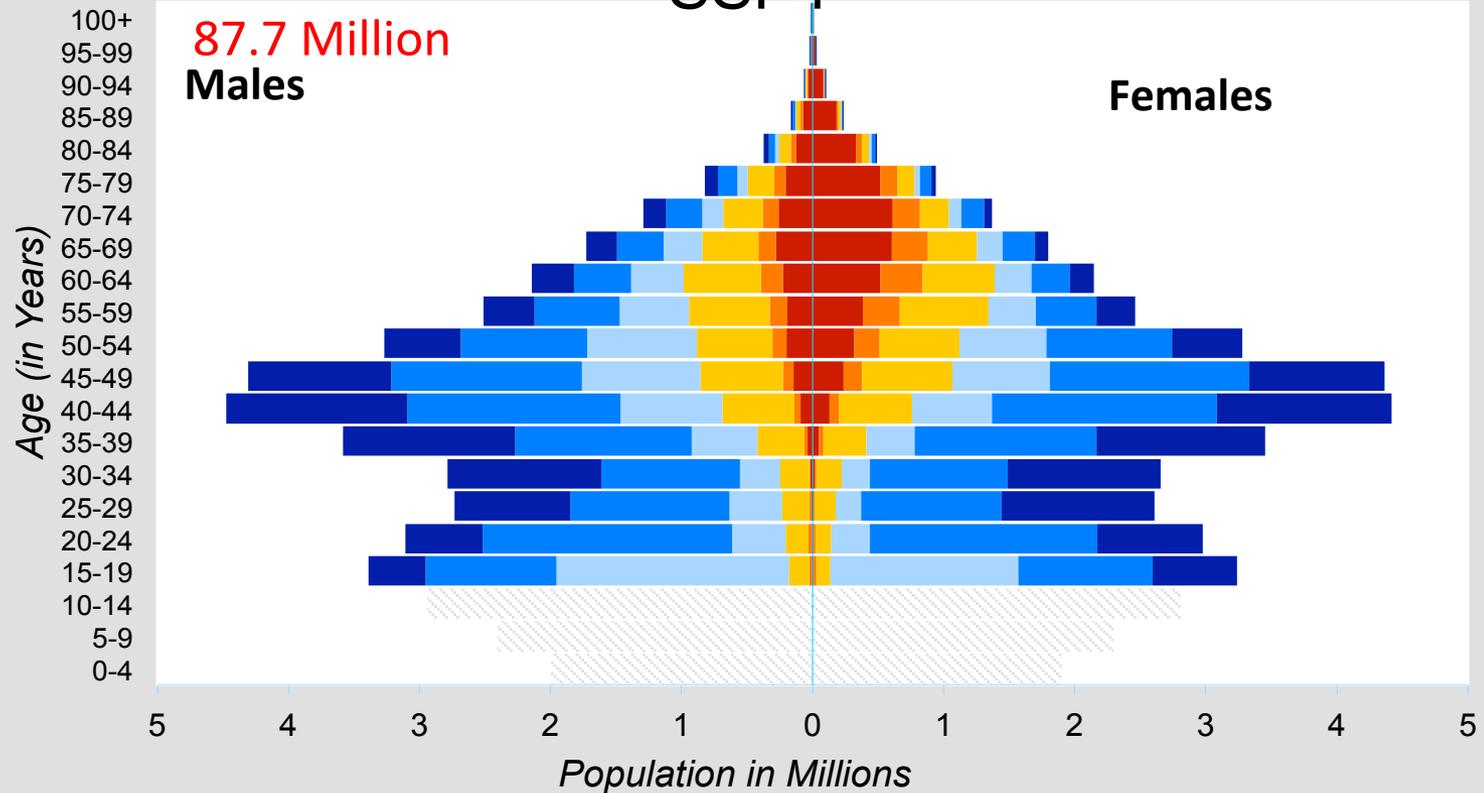
Population of Iran

Iran (Islamic Republic of) - Base Year 2010



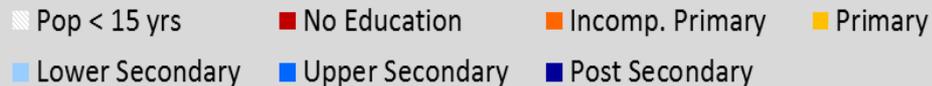
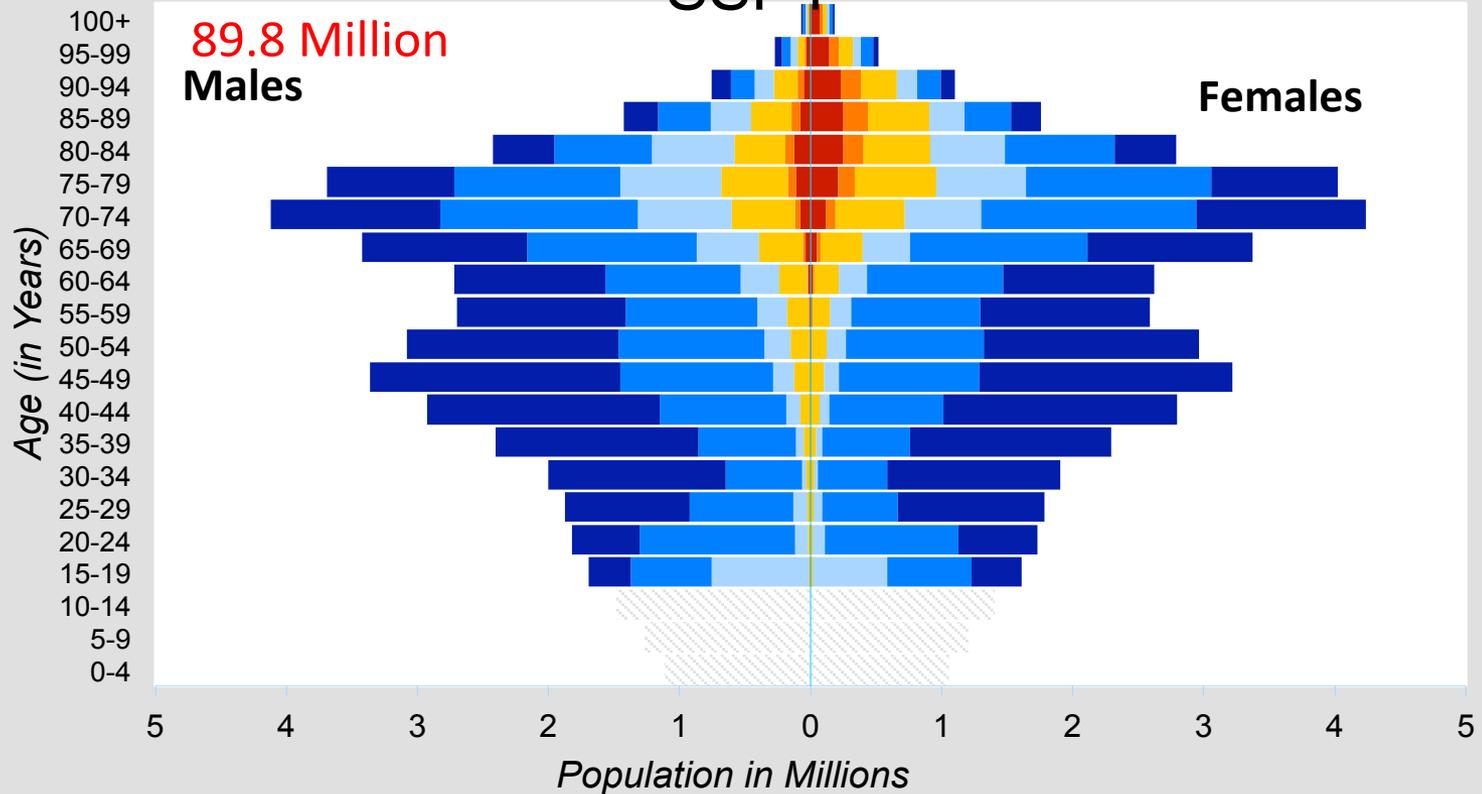
Population of Iran

Iran (Islamic Republic of) - Projections 2030 - SSP1



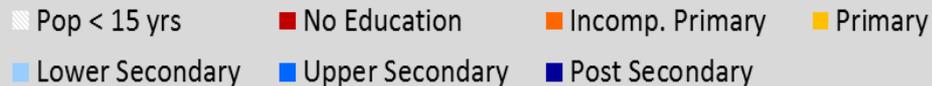
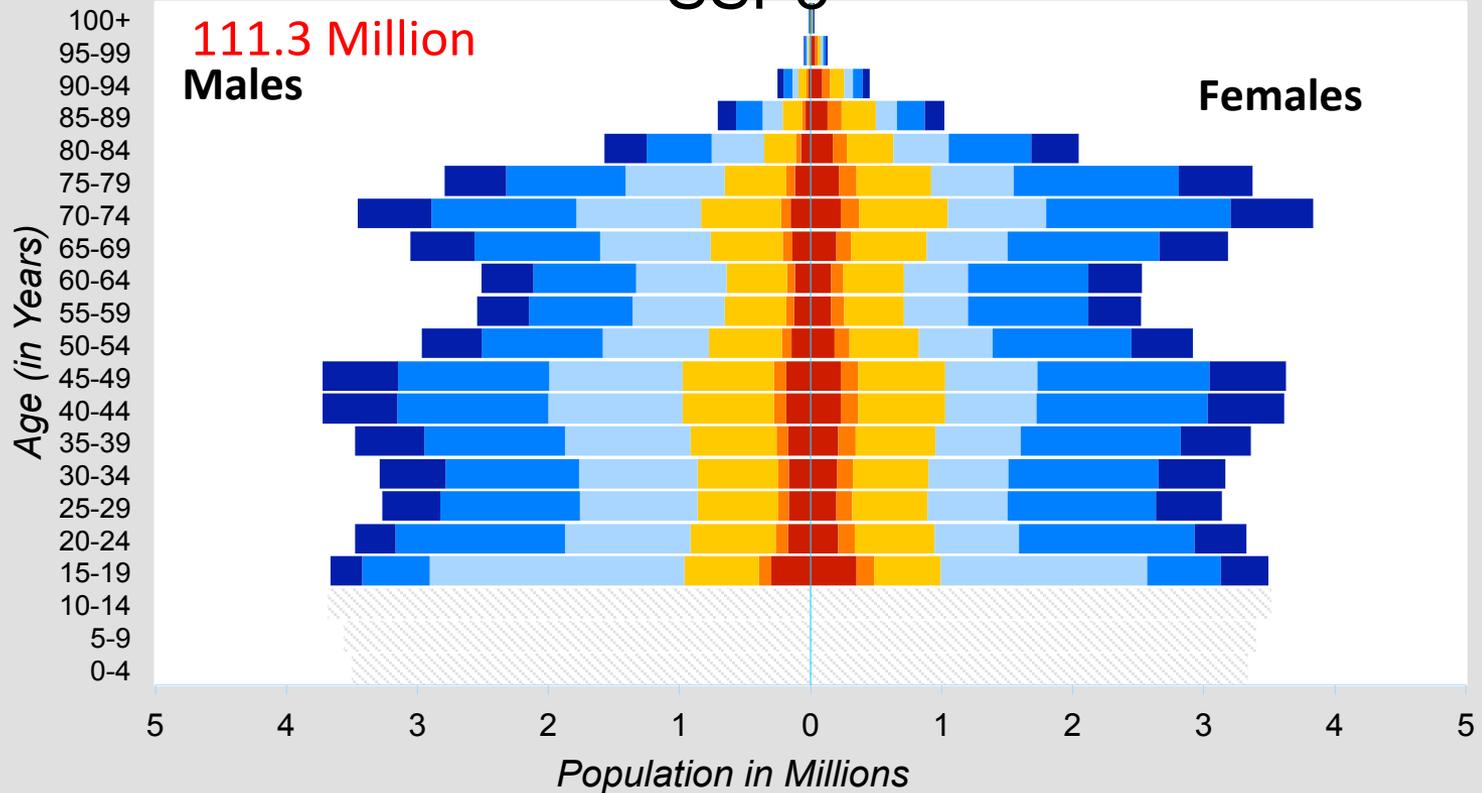
Population of Iran

Iran (Islamic Republic of) - Projections 2060 - SSP1



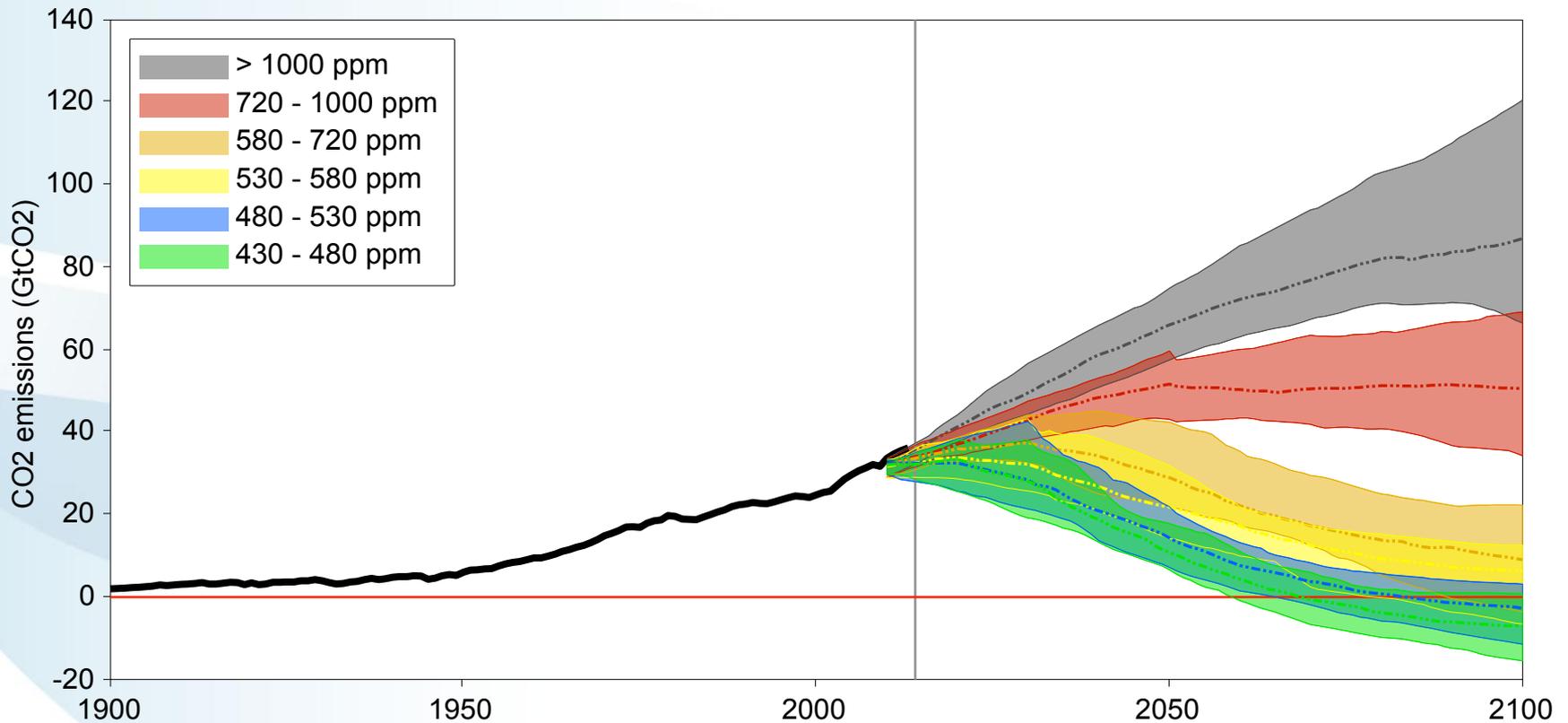
Population of Iran

Iran (Islamic Republic of) - Projections 2060 - SSP3

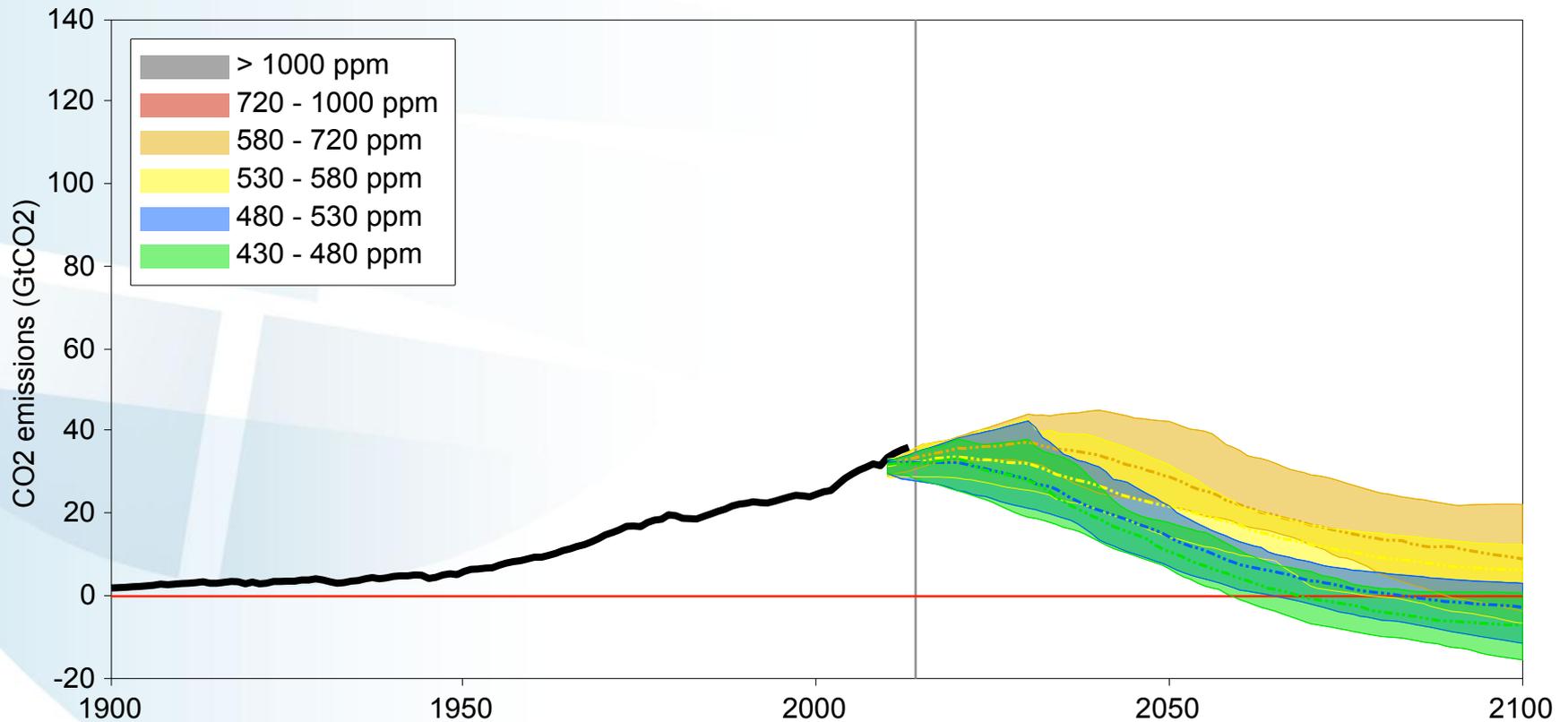


- Economic variables and damage function higher uncertainty than climate variables
- Half of the uncertainty is due to climate and earth systems models (climate and earth-systems sensitivity) while the other half is related to the range of alternative scenarios
- Half of the scenario uncertainty is reduced by eliminating low stabilization alternatives or vice versa – normative assumptions result in reduced conditional uncertainties

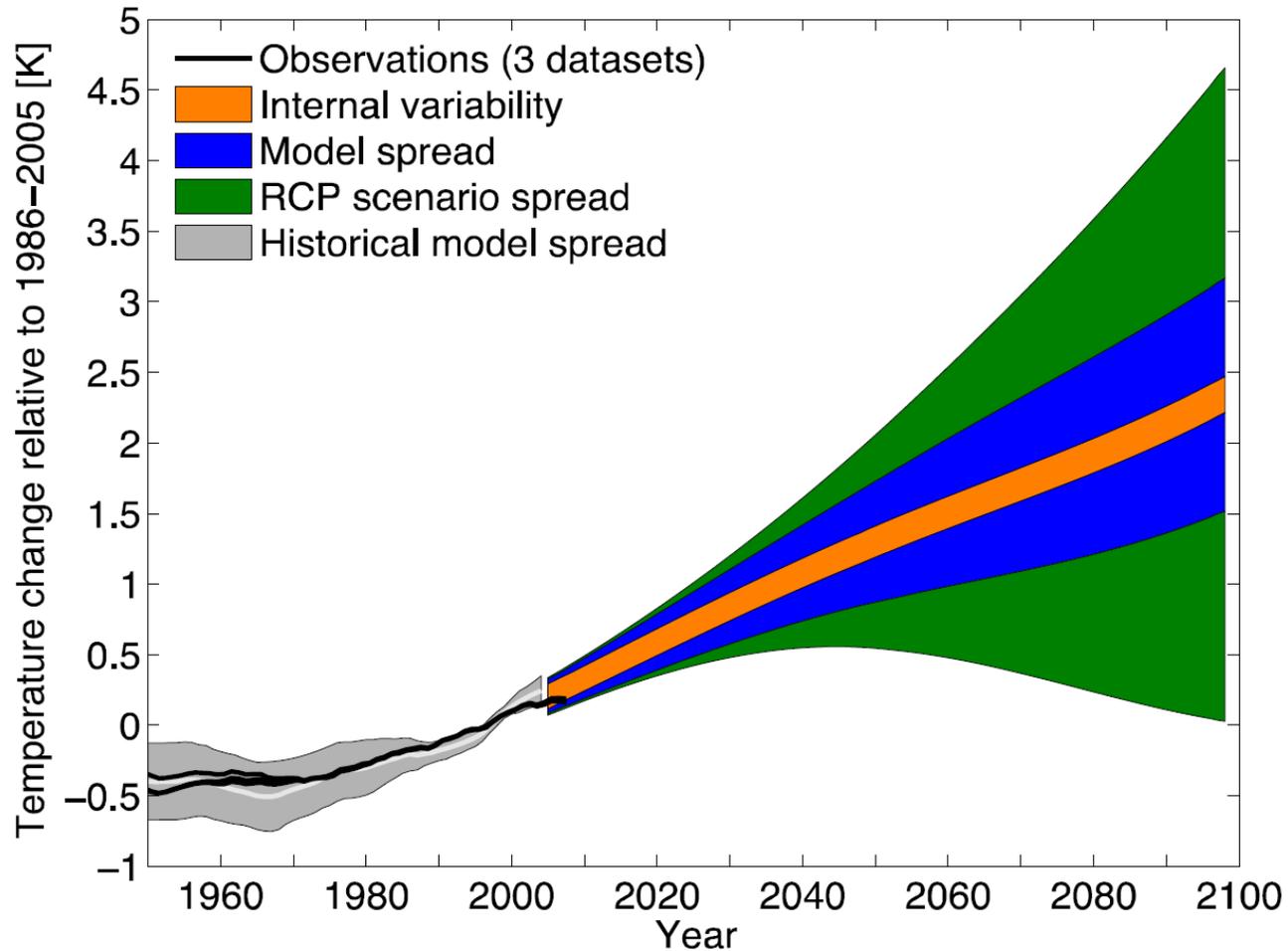
Global CO₂ Emissions IPCC AR5



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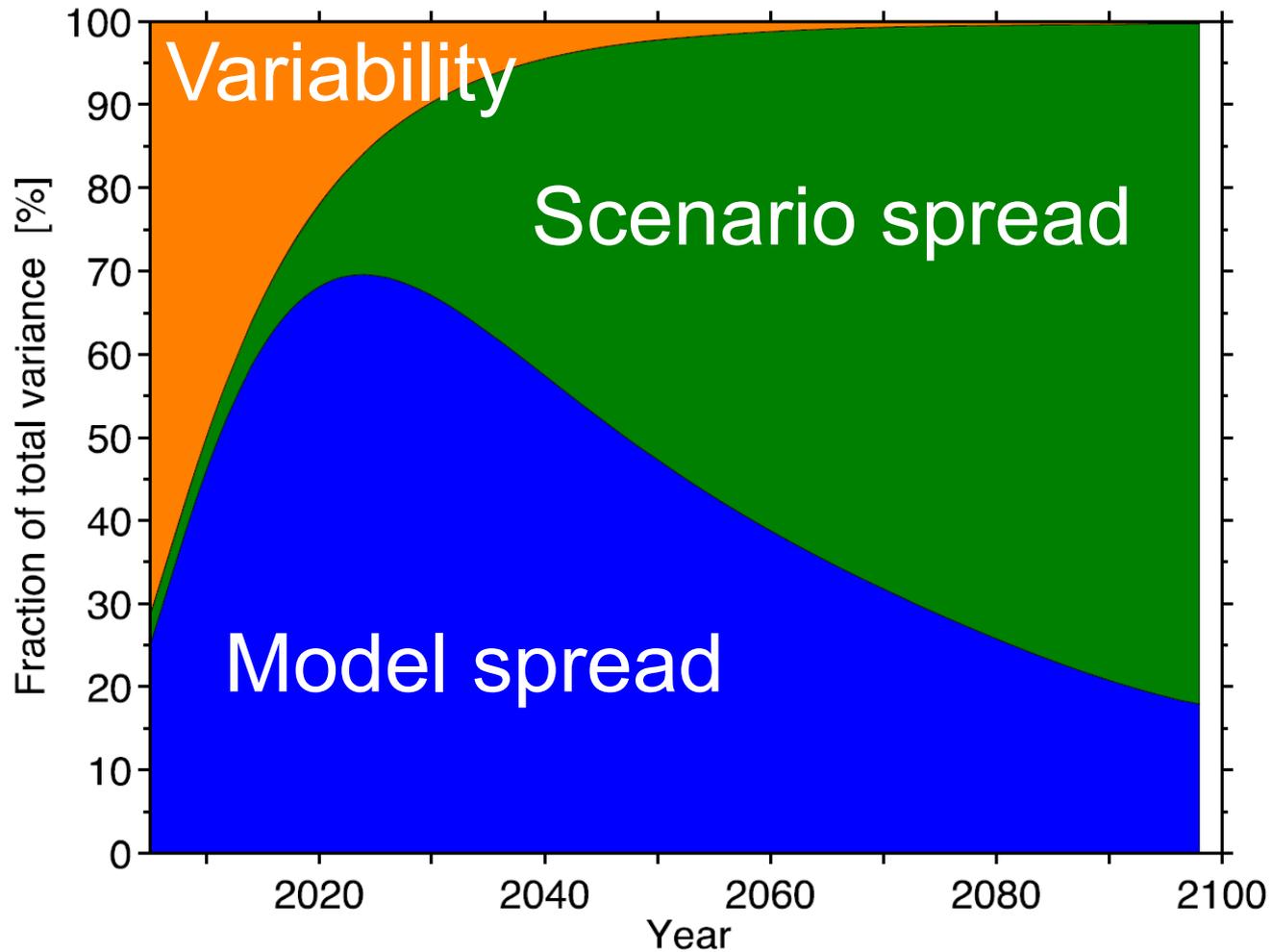


Sources of Uncertainty in Future Global Mean Temperature



(a)

Uncertainty in Global Mean Decadal Temperature

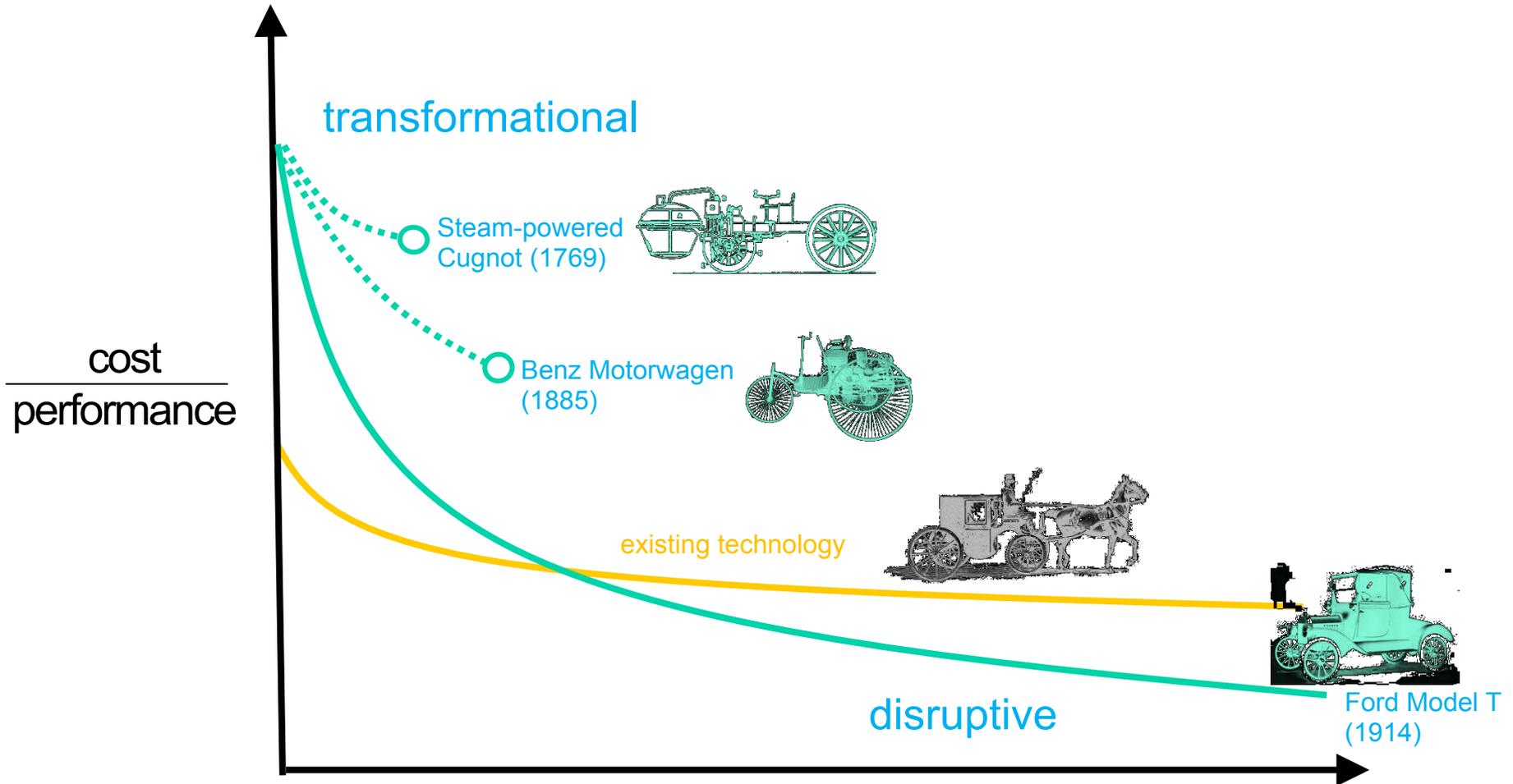


- Similar projections of baseline parameters, diverging in alternative cases (high levels)
- Model comparisons (“aerobics”) and ensembles with similar (harmonized) assumptions would tend to eliminate the “tails” and emphasize central assumptions
- They may even lead to “shared” functional relationships
- Model “parameterizations” may be favored that result in “stability” of outputs in case of great variations of input assumptions

- Distributions of key outputs very similar, e.g. quintiles vary by less than $\frac{1}{2}^{\circ}\text{C}$
- Climate “modules” may be very similar as they are often “models” of models, e.g. resulting from CMIP exercises
- May be case of another dimension of model comparisons that clip the tails and strengthen central estimates

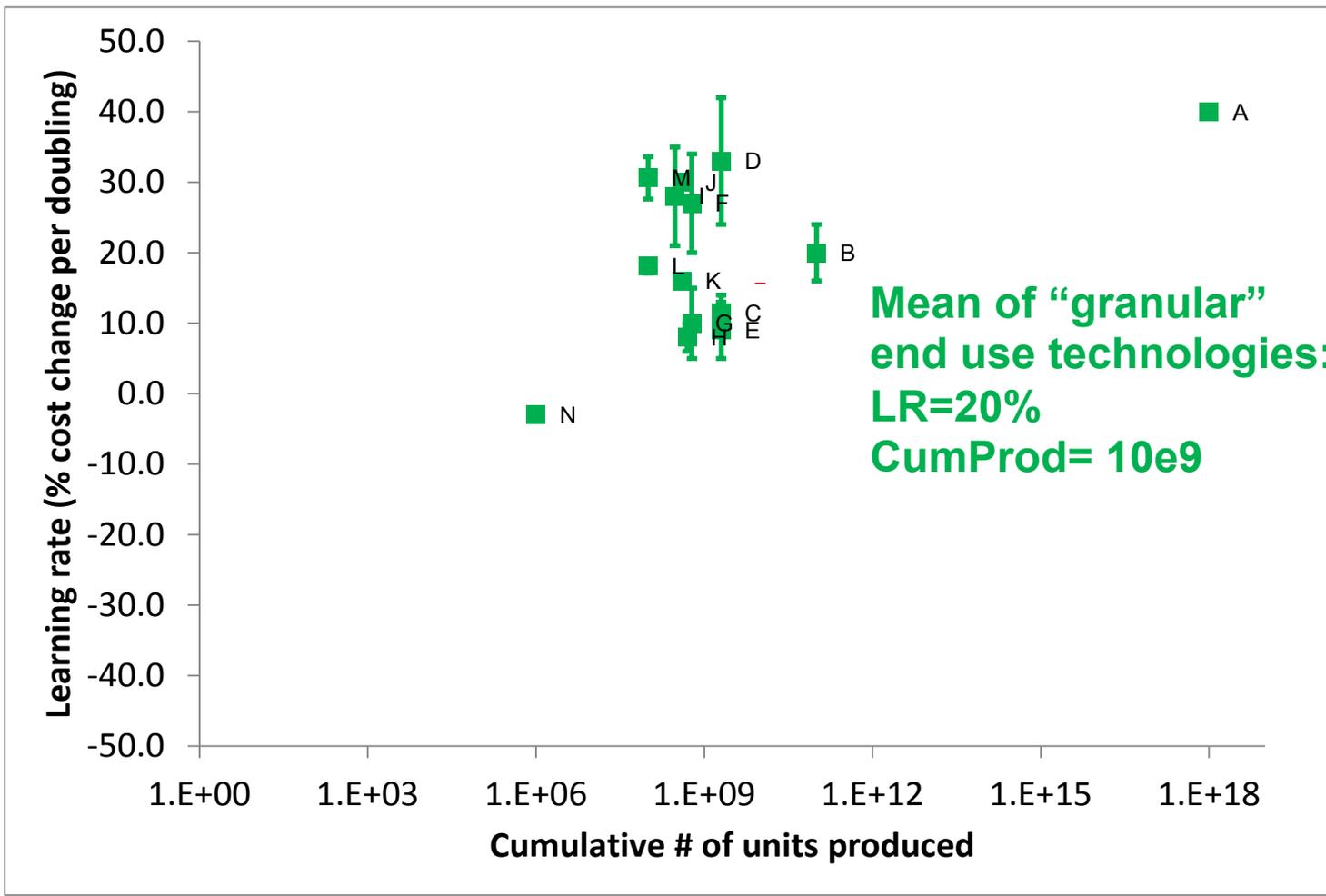
- Doubling all uncertainties results in almost doubling of the output uncertainties
- Little evidence for “fat” tails of outputs
- Going beyond the “black box” of technology important to capture sources of uncertainty
- Paradox of technology: a source and solution of development and climate change

Incremental & Disruptive Technologies



Cumulative Experience and Learning

The Importance of “granularity”



- A Transistors
- B DRAMs
- C Automobiles
- D Washing machines
- E Refrigerators
- F Dishwashers
- G Freezers (upright)
- H Freezers (chest)
- I Dryers
- J Calculators
- K CF light bulbs
- L A/C & heat pumps
- M Air furnaces
- N Solar hot water heaters

Going “Beyond” Climate Uncertainties

- **Better integration across science communities**
 - “Climate or development first” approach too narrow
- **More integrated & holistic assessment of climate change policy in the context of other priorities:**
 - Multi-objective & multi-policy framing to better understand climate policy tradeoffs & benefits
 - “Nexus” approaches to reach multiple objectives simultaneously: energy, water, food & urbanization
- **Challenges are huge:**
 - Different constraints and priorities across scales
 - Normative goals involved in policy prioritization