

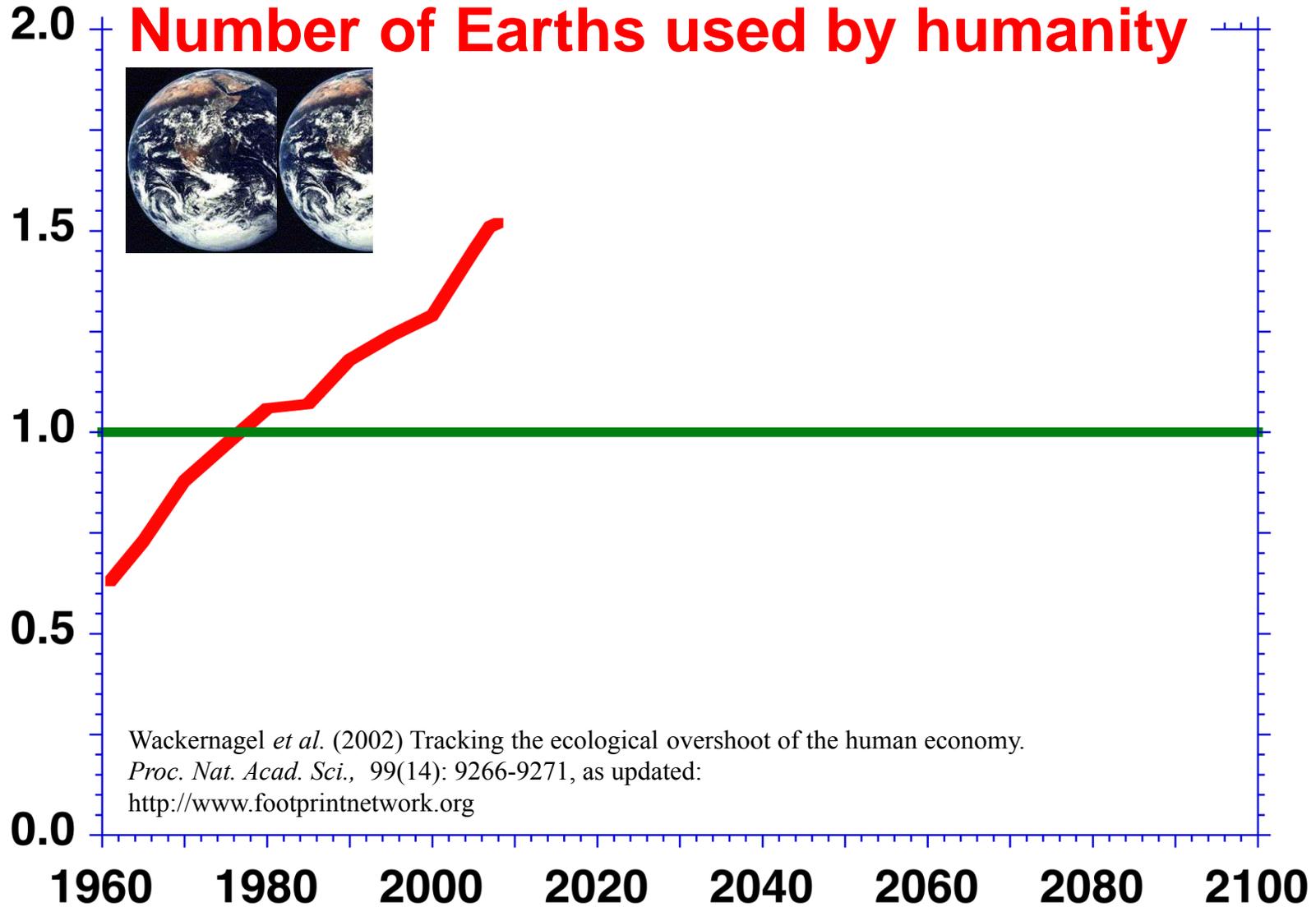
Global Models from Malthus to C-ROADS and Beyond

John Sterman, MIT Sloan

Tom Fiddaman, Ventana Systems

Drew Jones, Climate Interactive

Global Human Ecological Footprint



Impact of Global Modeling on Mental Models, Institutions, and Policy



Before

After

World Dynamics

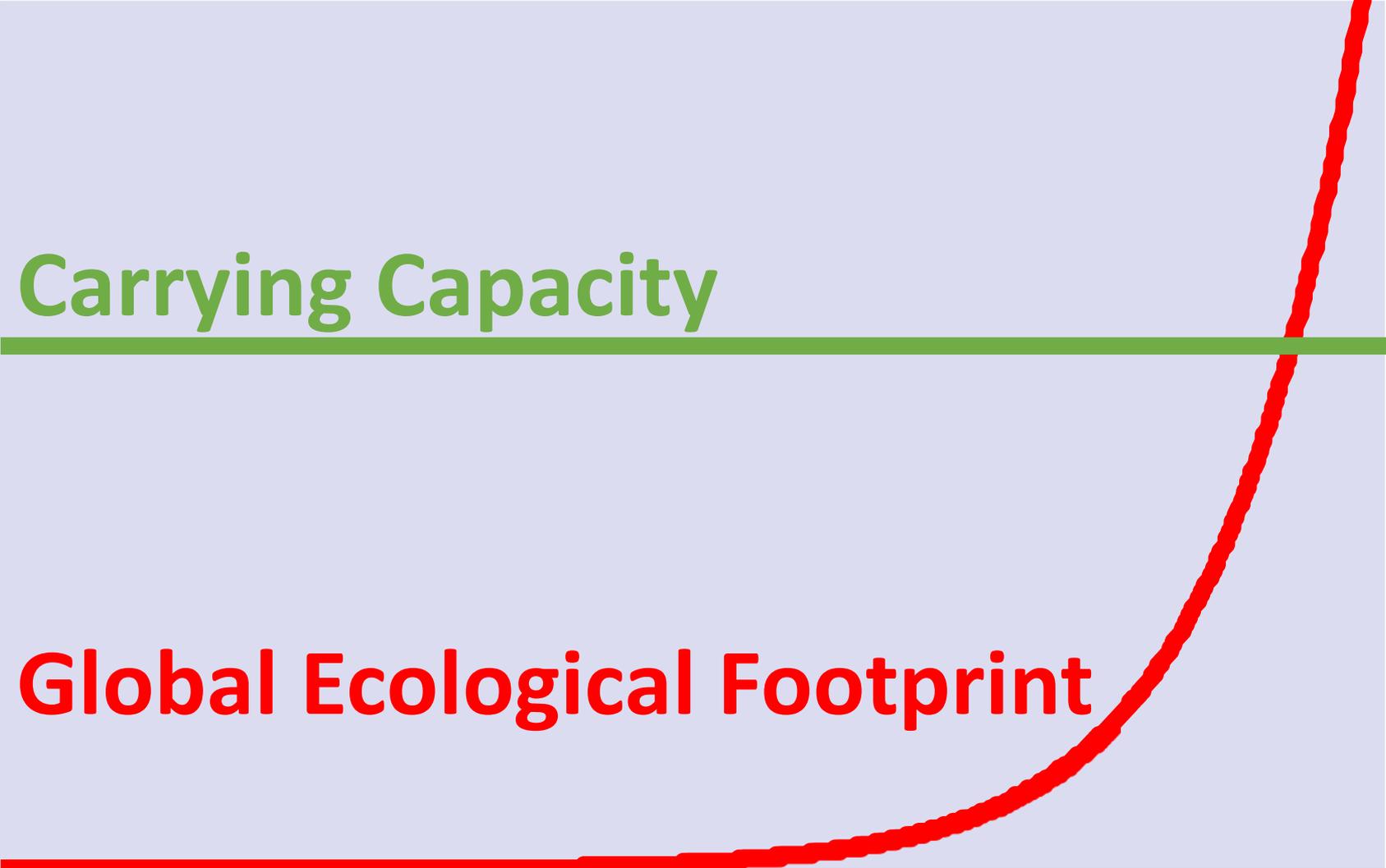
Before

Limits are remote

Growth is good

The very idea of modeling
global systems is suspect

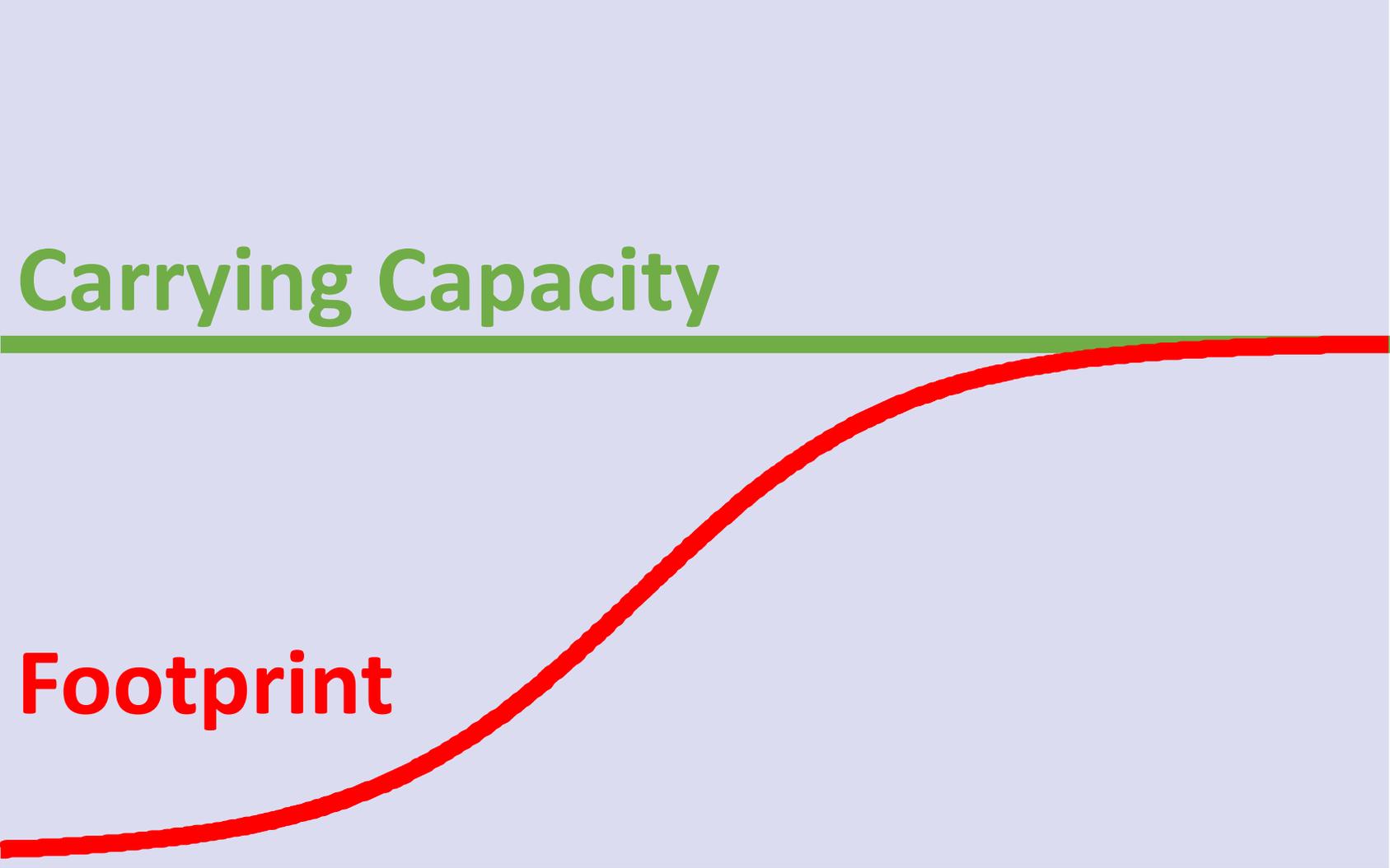
No measurement system to
assess limits



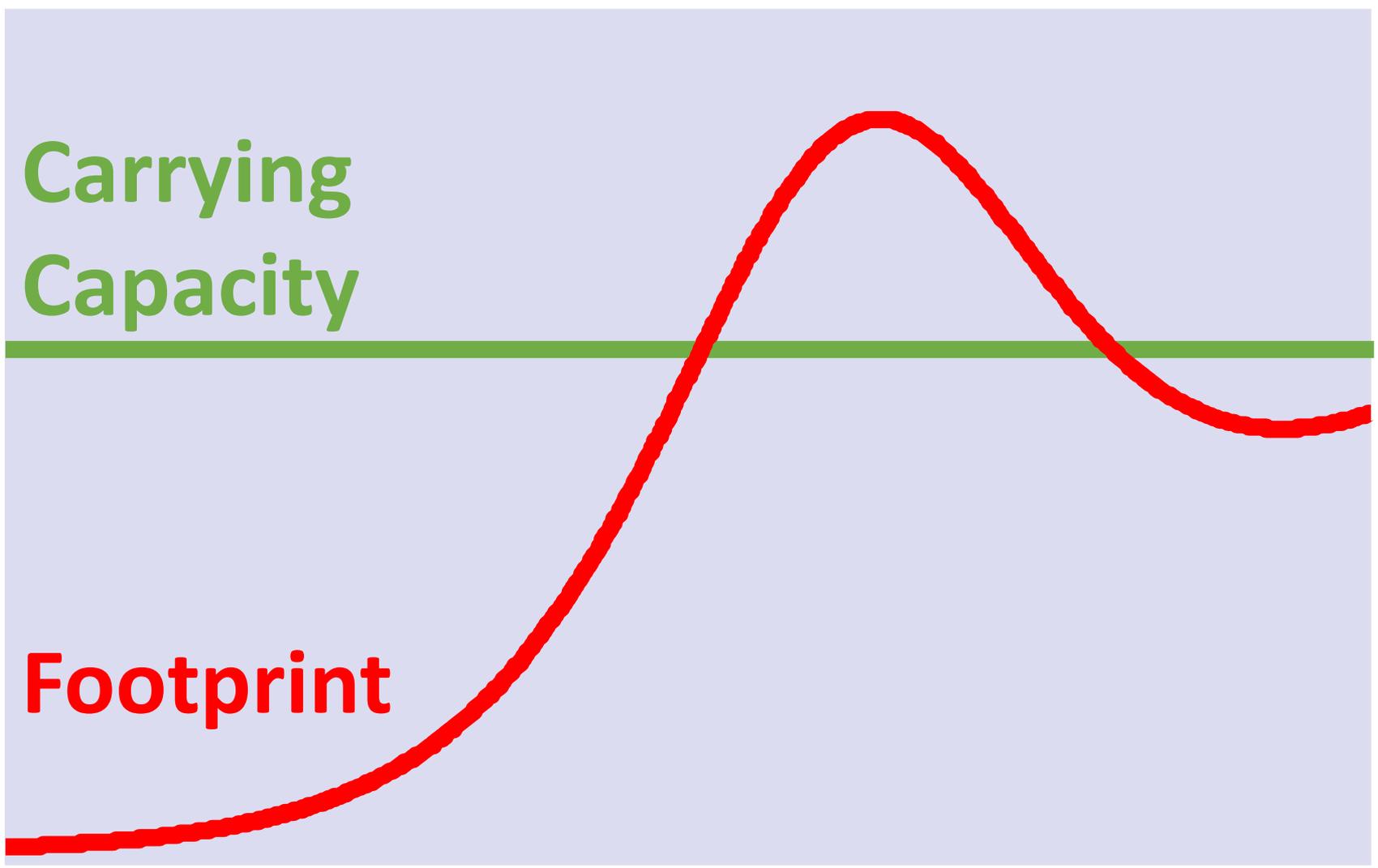
Carrying Capacity

Global Ecological Footprint

Carrying Capacity

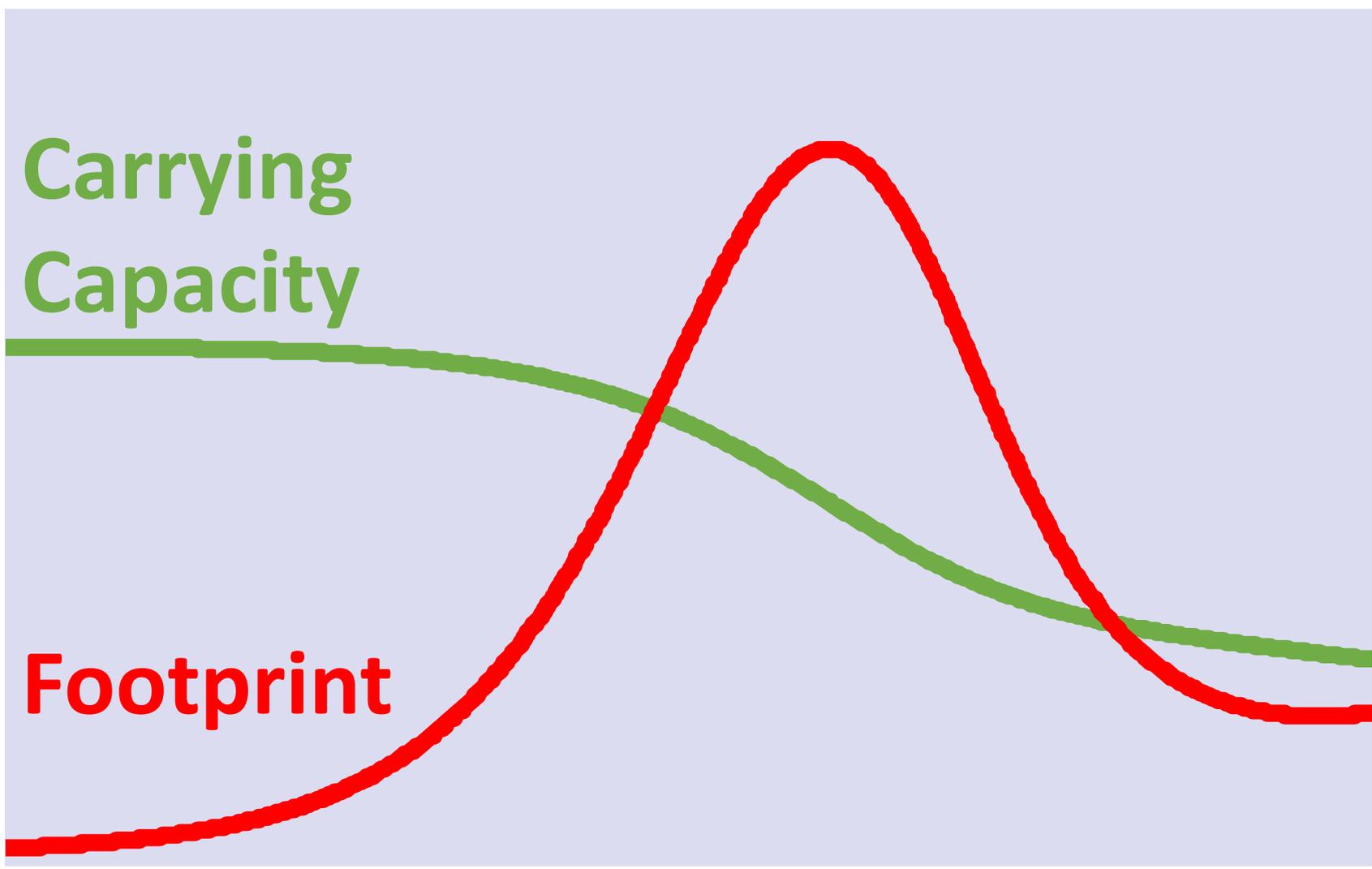
A conceptual graph on a light blue background. A horizontal green line is positioned in the upper third of the frame, labeled 'Carrying Capacity'. A thick red curve starts at the bottom left, rises steeply in an S-shape, and levels off just below the green line as it moves towards the right edge of the frame. The word 'Footprint' is written in red text in the lower-left area of the graph.

Footprint



**Carrying
Capacity**

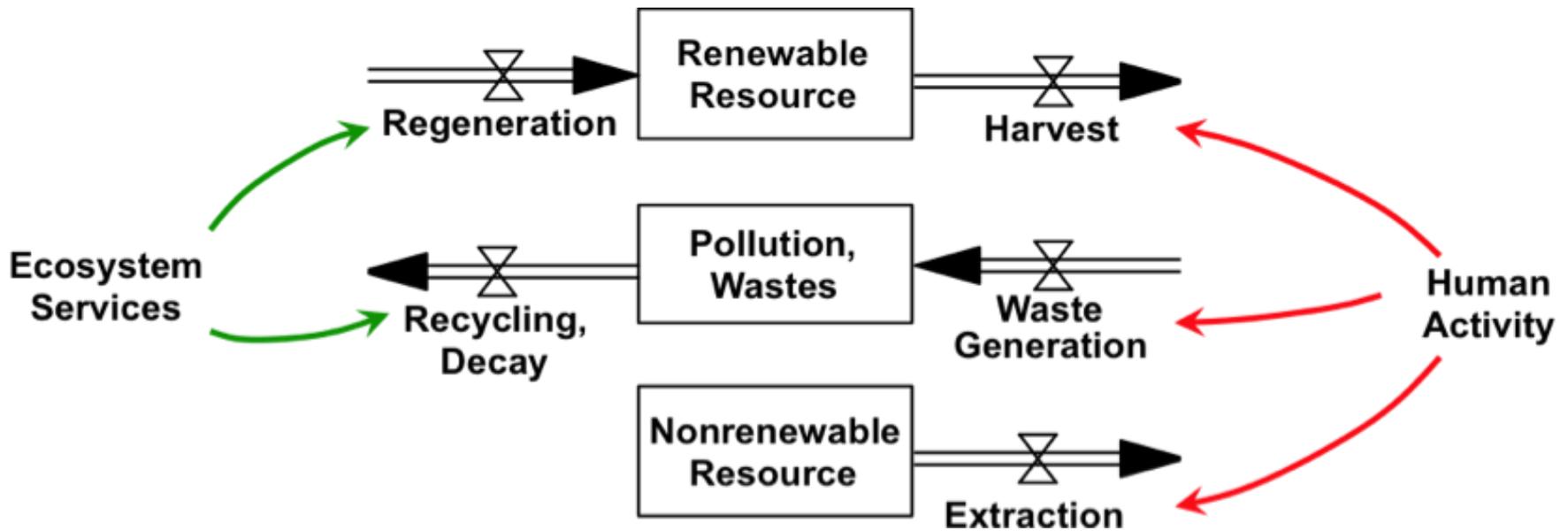
Footprint



Carrying Capacity

Footprint

Necessary Conditions for Sustainability



1. Renewable resources

can be used no faster than the rate at which they regenerate.

2. Pollution and wastes

can be emitted no faster than they can be recycled or rendered harmless.

3. Nonrenewable resources

cannot, in the long run, be used at all.

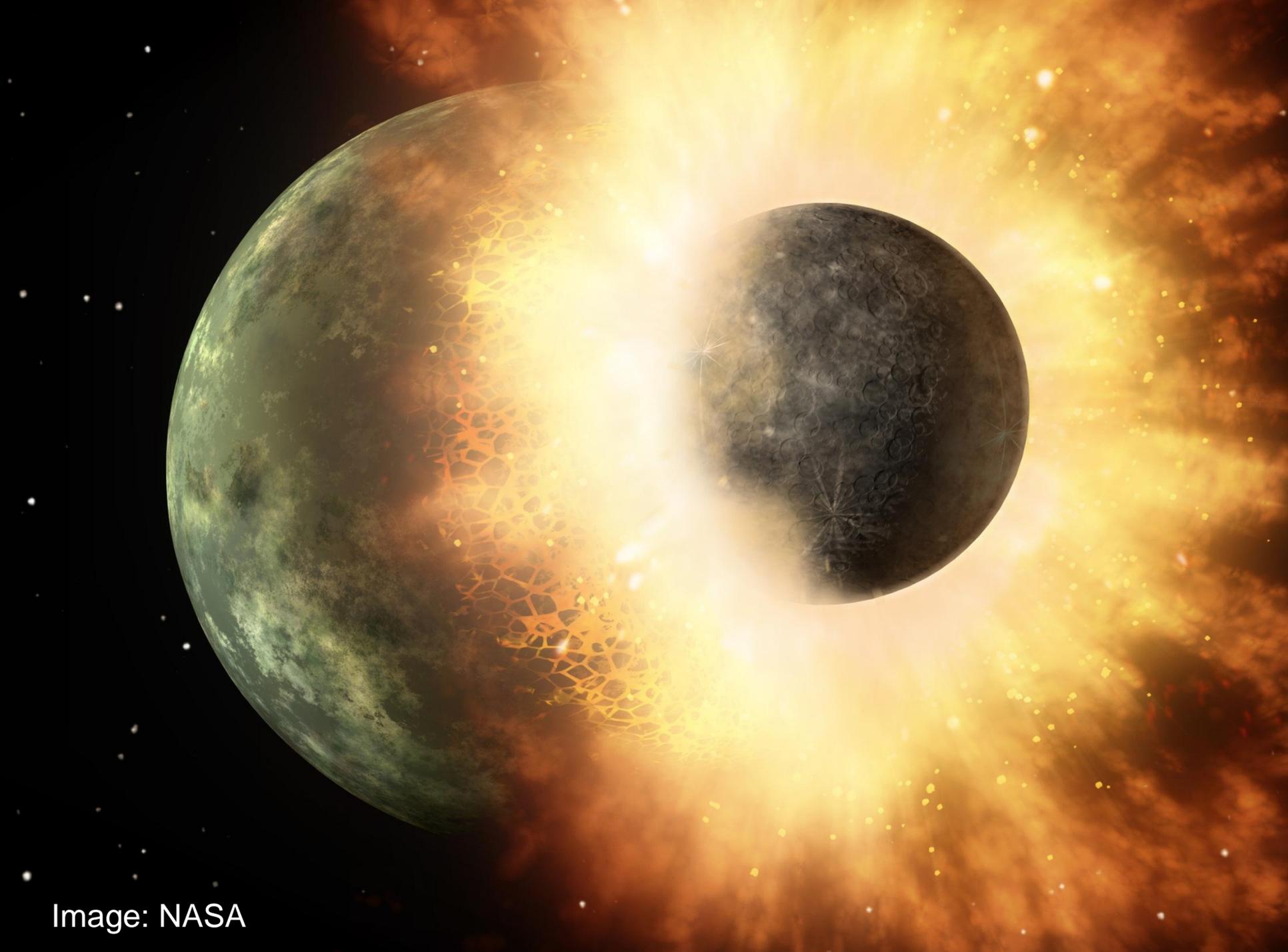


Image: NASA

These thresholds are well beyond current levels of human activity. Moreover, our limited supply of fossil fuels limits the production of CO_2 to acceptable levels.

W. D. Nordhaus (1974) "Resources as a Constraint on Growth" *AER* 64(2)

Yet mankind is playing dice with its natural environment through a multitude of interventions--injecting trace atmospheric gases like the greenhouse gases or ozone-depleting chemicals, engineering massive land-use changes such as deforestation, ...

Nordhaus (1994) *Managing the Global Commons*

Consumption per capita

(DICE, Nordhaus (1992) *Science*)

“Can we treat seriously Forrester’s (or anybody’s) predictions in economics and social science for the next 130 years?” – Nordhaus (1974)

1965

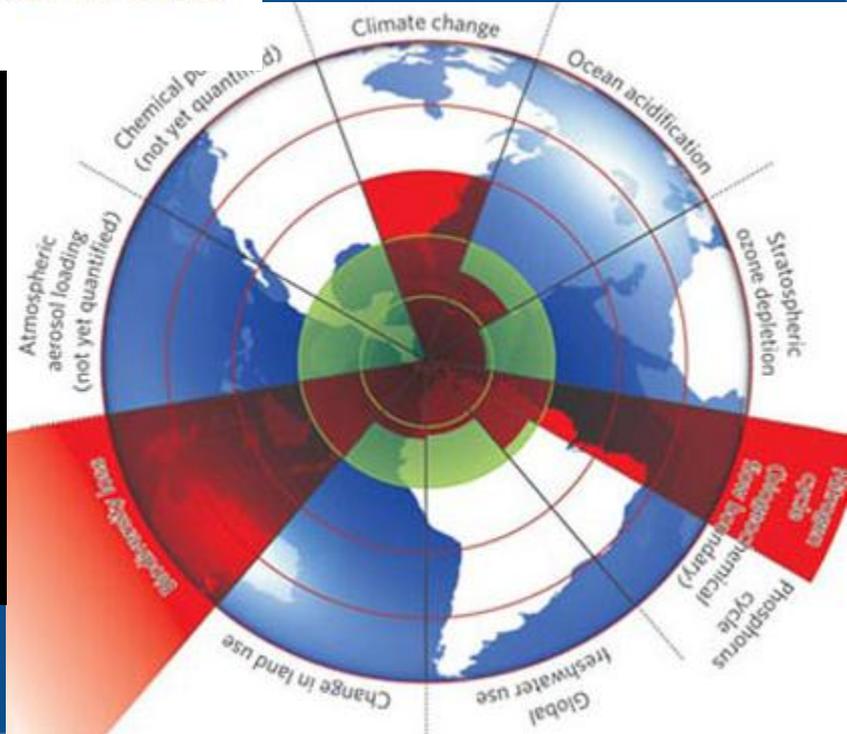
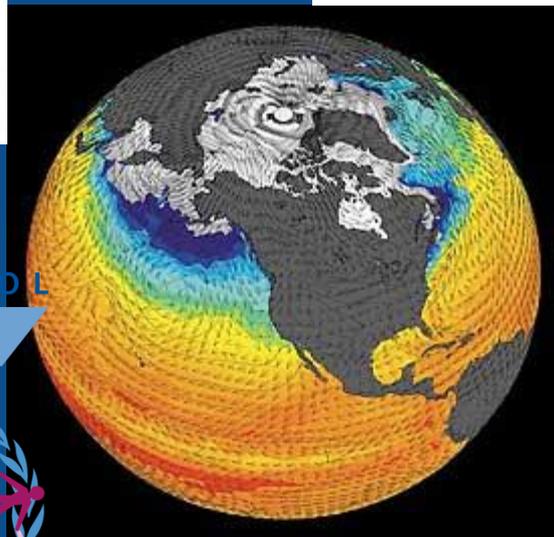
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World Dynamics

After

ipcc

INTERGOVERNMENTAL PANEL ON
climate change



MONTREAL PROTOCOL

25

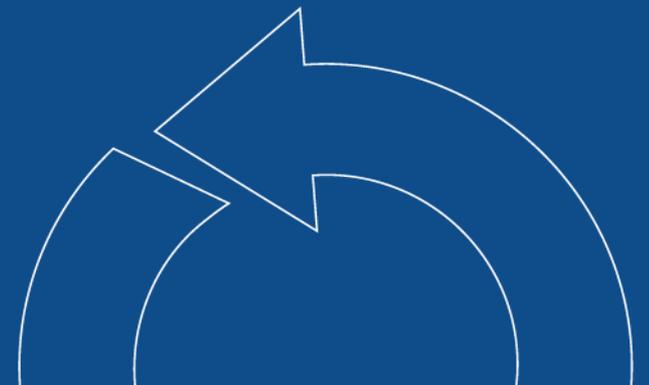
1987-2012



UN Climate

Before

Country pledges to the UN
are good enough



3.9 degrees, 770 ppm

CONFIDENTIAL VERY INITIAL DRAFT

Do not distribute

DRAFT, 15/12/09, 23.00

Climate Interactive

**Preliminary assessment of pledges made by Annex I Parties and
voluntary actions and policy goals announced by a number of
non-Annex I Parties**

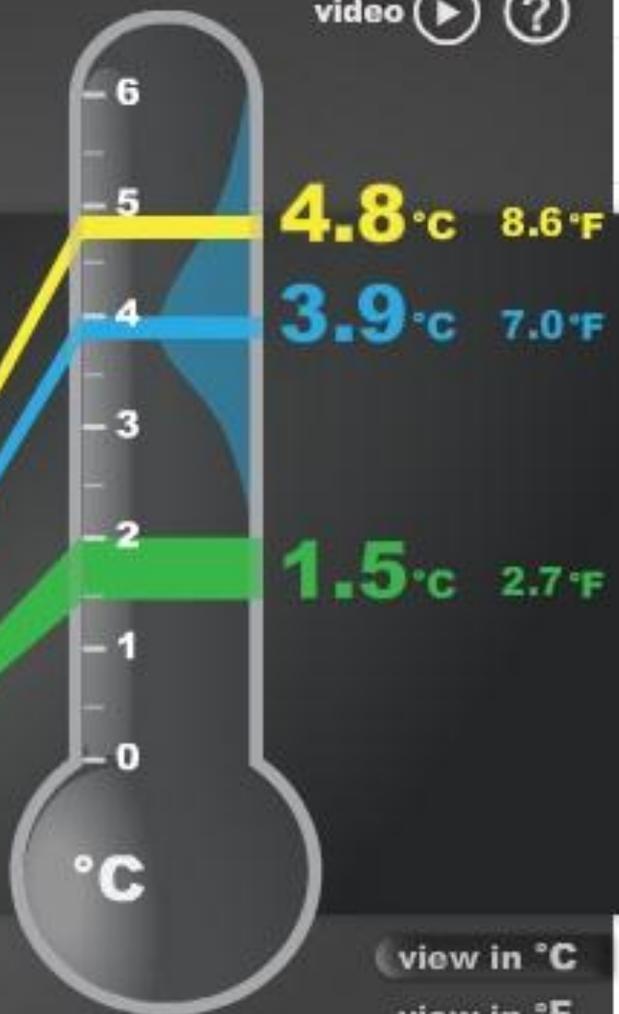
Climate Sachsead

Internal Note by the Secretariat

Increase in Global Temperature by 2100

Where will proposals from the climate negotiations lead?

business as usual
Dec 18 proposals
goals

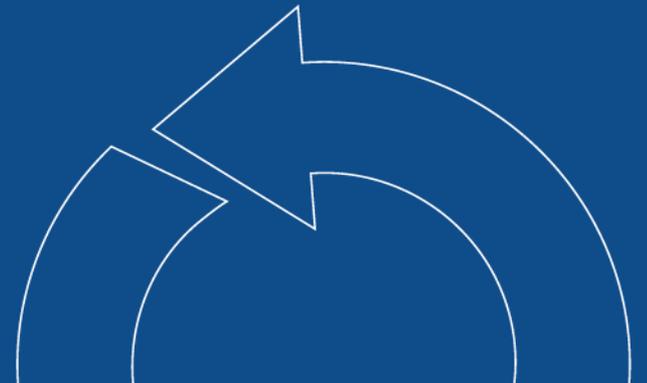


view in °C
view in °F

5% below 1990 levels by 2020 **Brazil:** Amazon deforestation rat

After

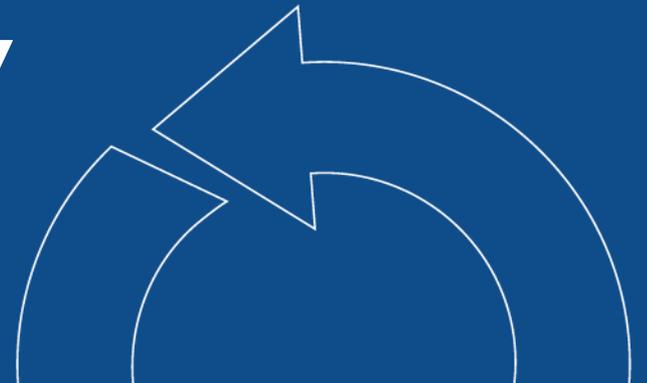
- Country pledges to the UN are not enough
- Process for tracking using C-ROADS & other models



Mr. X

Before

- Energy efficiency is “Cute”
- Renewable energy is “Inconsequential”
- Only real answer = New zero-carbon energy technology



After

Mr. X

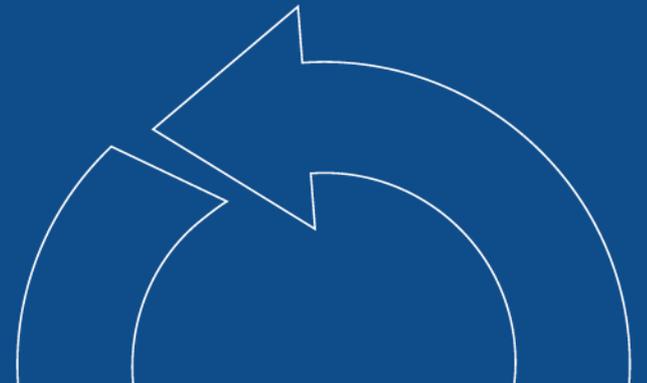
“[Mr. X] emphasized the need for investment and research in five areas – carbon capture, nuclear, solar, wind, and biofuels – and a concurrent focus on efficiency.”

- CNET



“[Mr. X] said energy moves slowly just by its nature. Unlike IT, ... its underlying hardware... takes decades to swap out.”

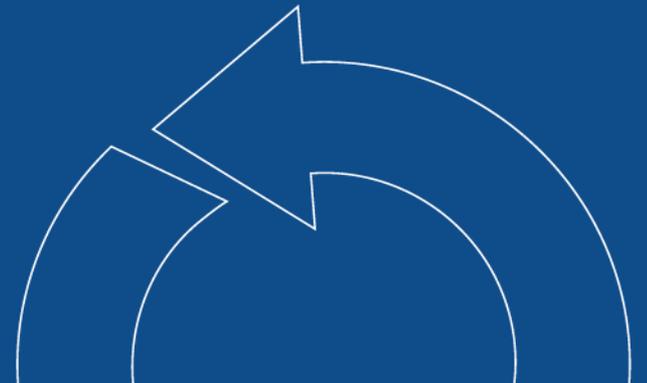
- CNET



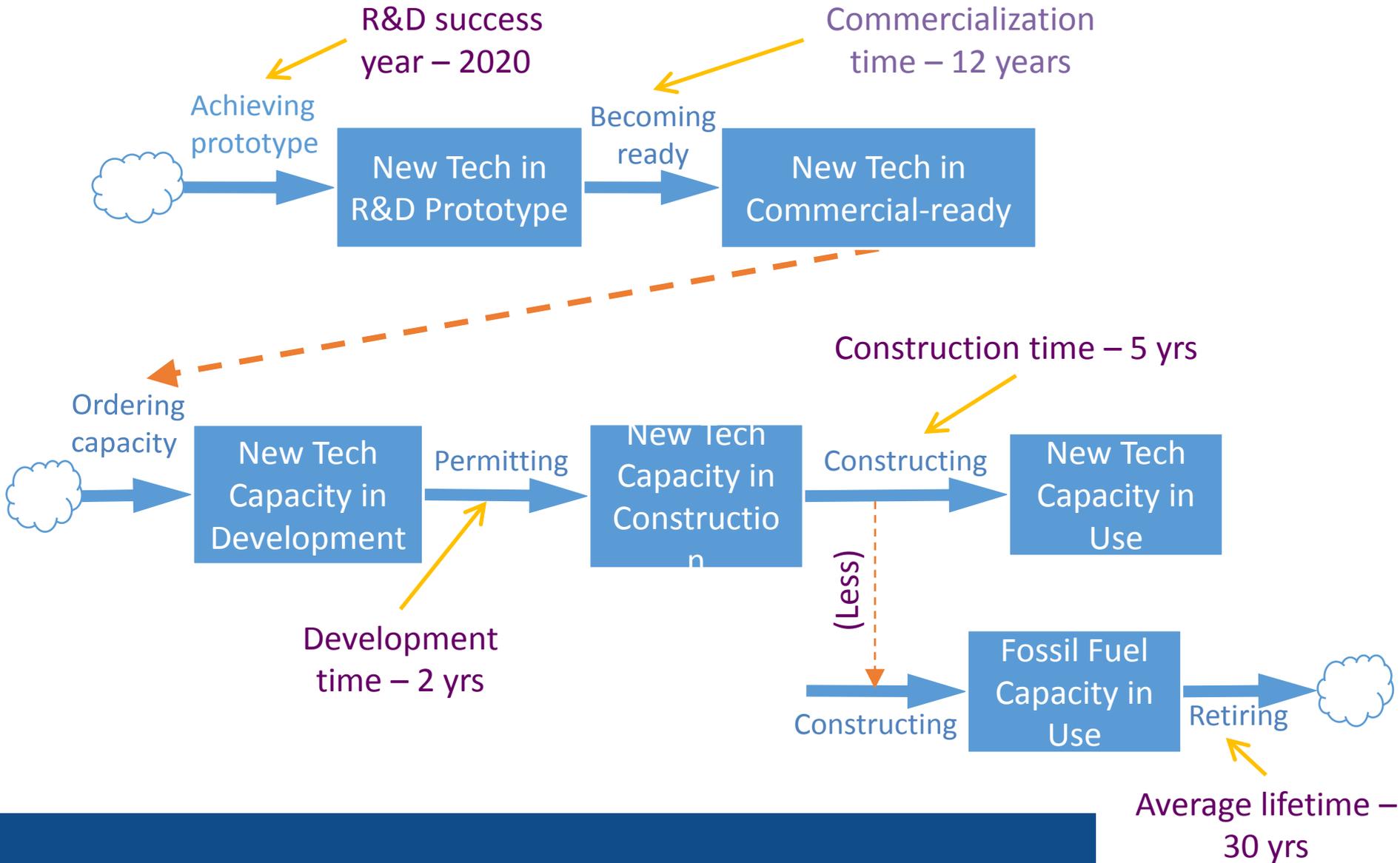


Backup slides

System Dynamics models of global dynamics have improved mental models, catalyzed the creation of new institutions and processes at all scales, and helped move the world towards effective action.



Transition Delays to New Tech

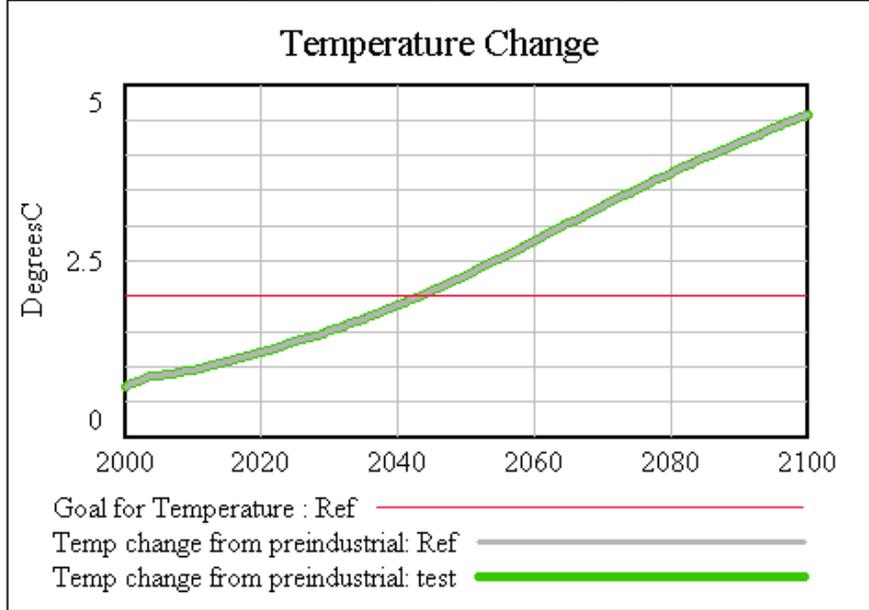
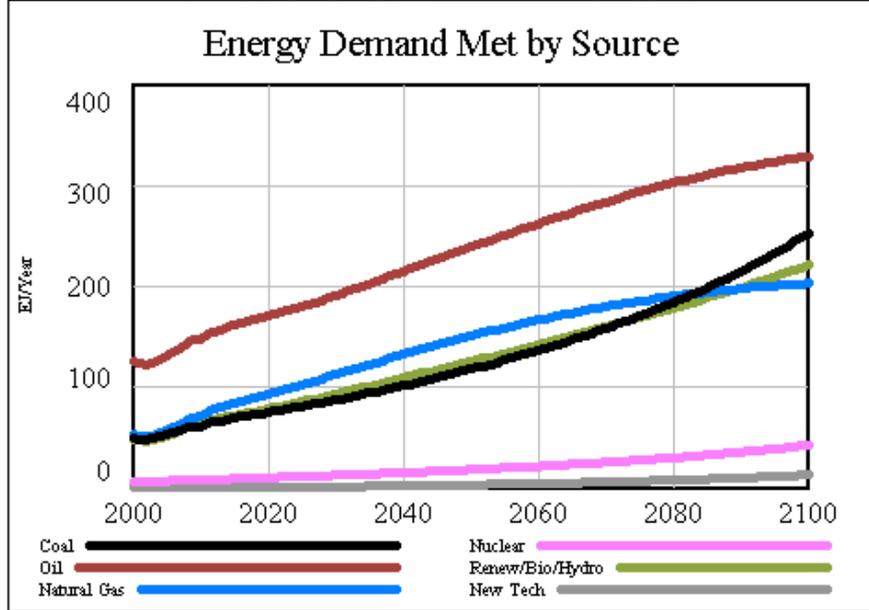


Our "Reference Scenario"

Main **En-ROADS Control Panel**
Kaya Demand Fuel Mix Settings
T= 4.6°C in 2100

Supply by Type % Share by Type

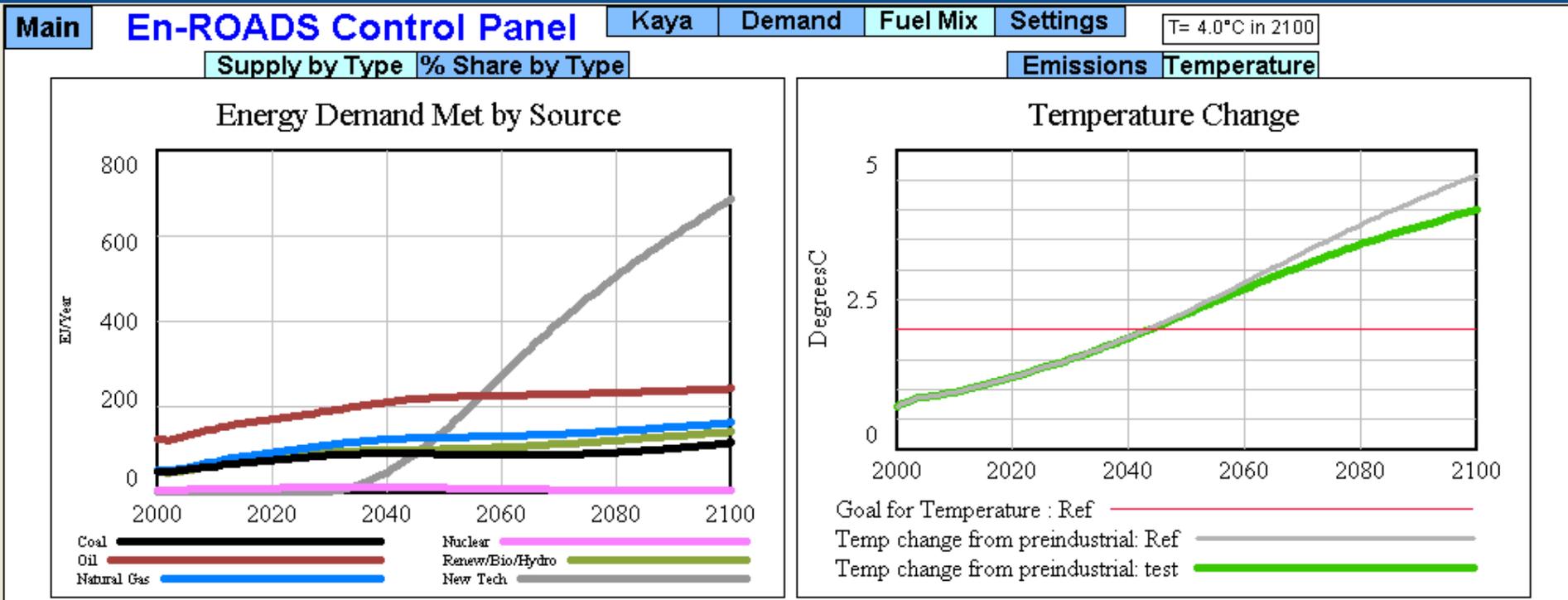
Emissions Temperature



	New Tech Policy	Carbon Policy	Energy Efficiency (New Capital)
Coal			
Oil			
Gas	Price <--> Subsidy	Emissions Price	Stationary <--> Mobile
Renewables	Breakthrough cost improvement from R&D	Emissions Performance Standard	GDP Growth Advanced
New Tech	Start year	Start Year	Short term <--> Long term
Biomass	Breakthrough year	Performance Standard Start Year	Land Use/Other
Nuclear	Stop year	Start Year	REDD <--> Other gases
		Advanced	



"New Tech" Alone



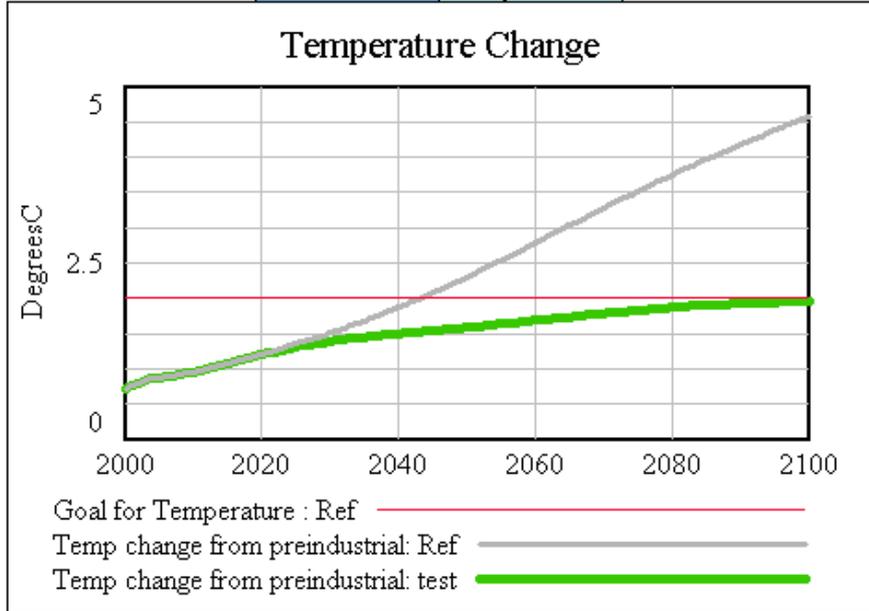
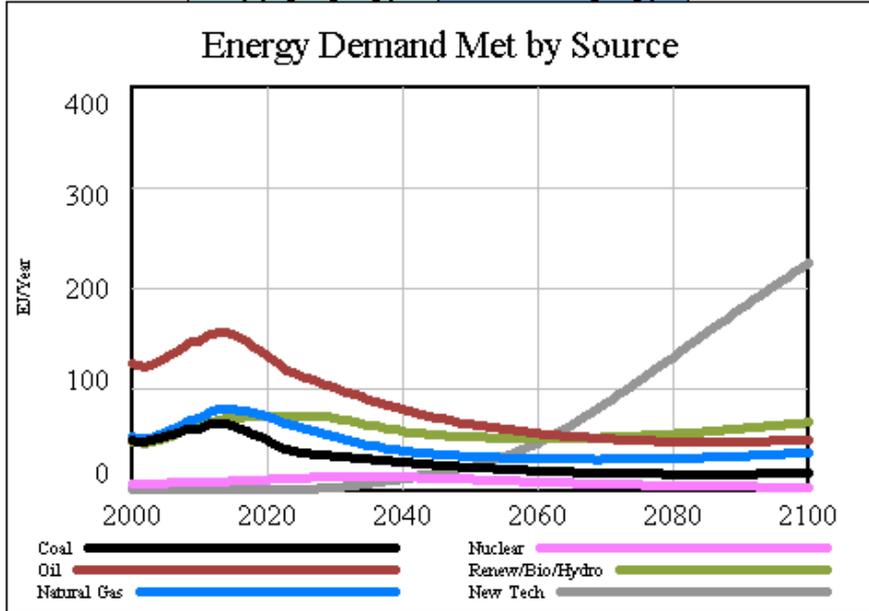
	New Tech Policy	Carbon Policy	Energy Efficiency (New Capital)
Coal			
Oil			
Gas	Price <--> Subsidy	Emissions Price	Stationary
Renewables	Start year	Emissions Performance Standard	Mobile
New Tech	Breakthrough cost improvement from R&D	Performance Standard Start Year	GDP Growth Advanced
Biomass	Breakthrough year	Start Year	Short term
Nuclear	Stop year	Advanced	Long term
			Land Use/Other
			REDD
			Other gases

Silver Buckshot

Main En-ROADS Control Panel Kaya Demand Fuel Mix Settings T= 2.0°C in 2100

Supply by Type % Share by Type

Emissions Temperature



	New Tech Policy	Carbon Policy	Energy Efficiency (New Capital)
Coal			
Oil			
Gas	Price <--> Subsidy	Emissions Price	Stationary <--> 5.1 <--> Mobile <--> 6.6
Renewables	Start year <--> 0 <--> Breakthrough cost improvement from R&D <--> 0.95	Emissions Performance Standard <--> 91 <--> 100	GDP Growth <--> 1.7 <--> 1.5 <--> Advanced
New Tech	Start year <--> 2013 <--> Breakthrough year <--> 2020	Performance Standard Start Year <--> 2013	Short term <--> Long term <-->
Biomass	Stop year <--> 2100	Start Year <--> 2013	Land Use/Other
Nuclear		Advanced	REDD <--> 89 <--> Other gases <--> 94