

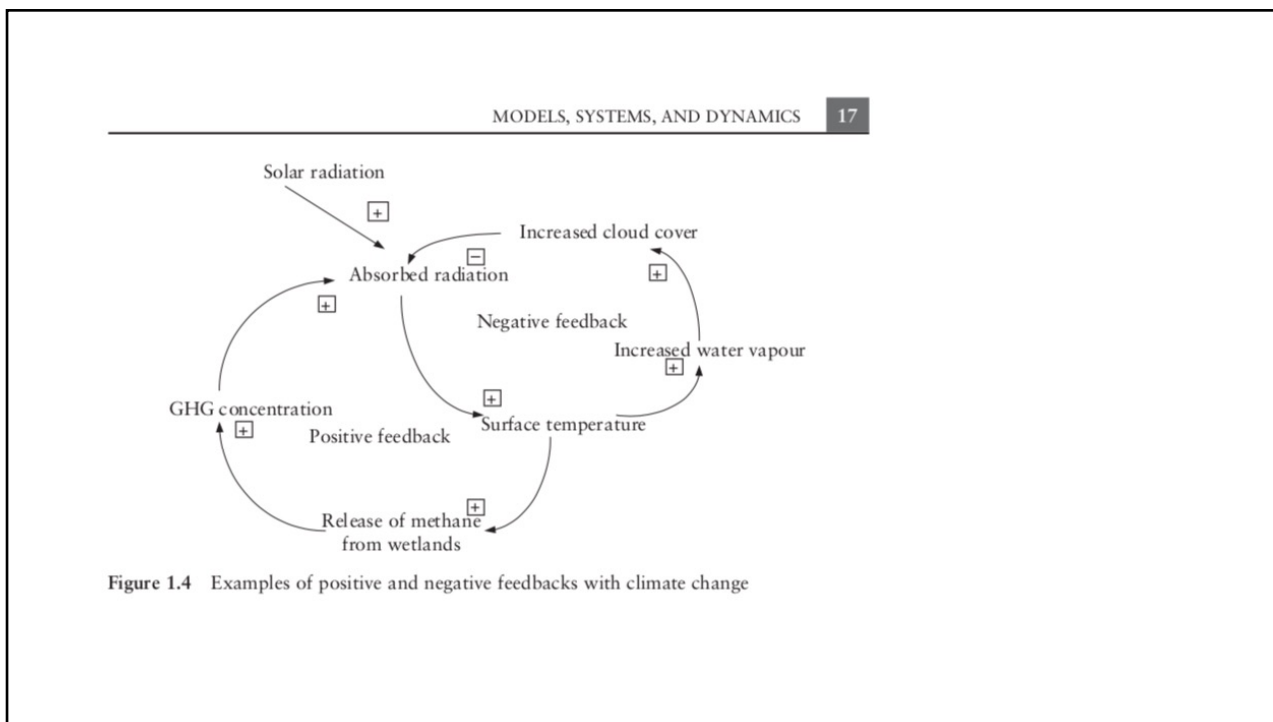
R. QUENTIN GRAFTON,  
WIKTOR ADAMOWICZ, DIANE DUPONT,  
HARRY NELSON, ROBERT J. HILL,  
AND STEVEN RENZETTI

## CONTENTS

<i>List of Figures</i>	ix
<i>List of Tables</i>	xii
<i>List of Boxes</i>	xiii
<i>Preface</i>	xv
<i>Acknowledgements</i>	xvi
<i>Introduction</i>	1
<b>Part I Economics of the Environment</b>	<b>5</b>
1 Models, Systems, and Dynamics	7
2 Property Rights	36
3 Economics of Pollution Control	61
<b>Part II Resource Economics</b>	<b>93</b>
4 Bioeconomics of Fisheries	95
5 Forestry Economics	129
6 Water Economics	161
7 Economics of Non-renewable Resources	193
<b>Part III Environmental Valuation</b>	<b>219</b>
8 Environmental Valuation: Introduction and Theory	221
9 Environmental Valuation: Stated Preference Methods	249
10 Environmental Values Expressed Through Market Behavior	277
<b>Part IV Global Environment</b>	<b>313</b>
11 Growth and the Environment	315
12 Environmental Accounting	344

# THE ECONOMICS OF THE ENVIRONMENT AND NATURAL RESOURCES

1



2

18 ECONOMICS OF THE ENVIRONMENT

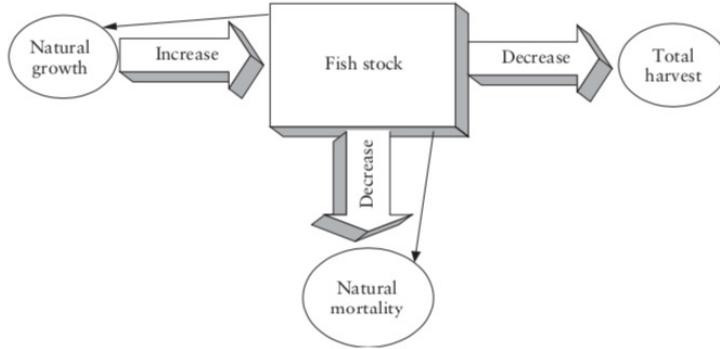
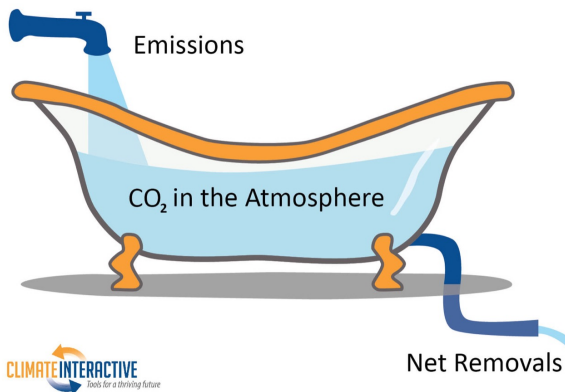
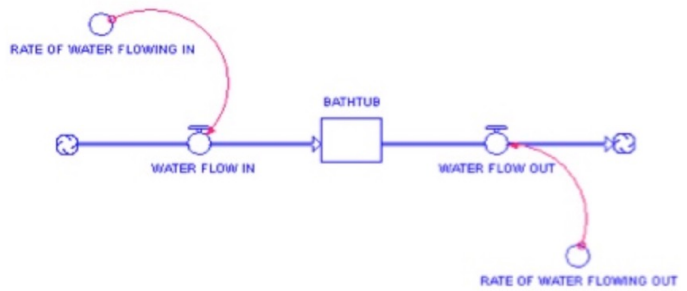


Figure 1.5 Stocks, flows, and feedbacks

3

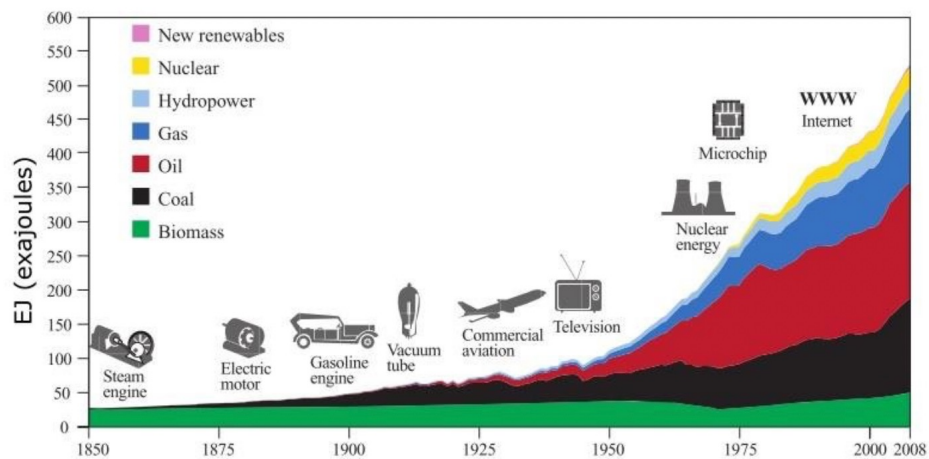


Overall framing by Dr. John Sterman, MIT Sloan



4

## Exponential growth



Historical global energy mix Source: Grubler et al. (2012).

5

5

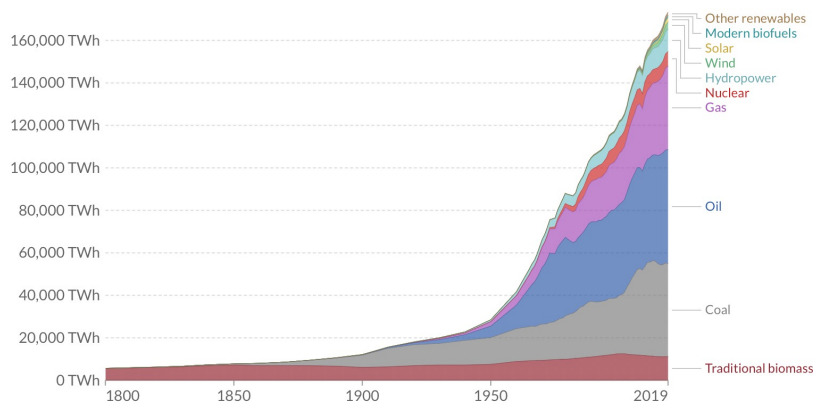
## Exponential growth?

### Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.



Relative

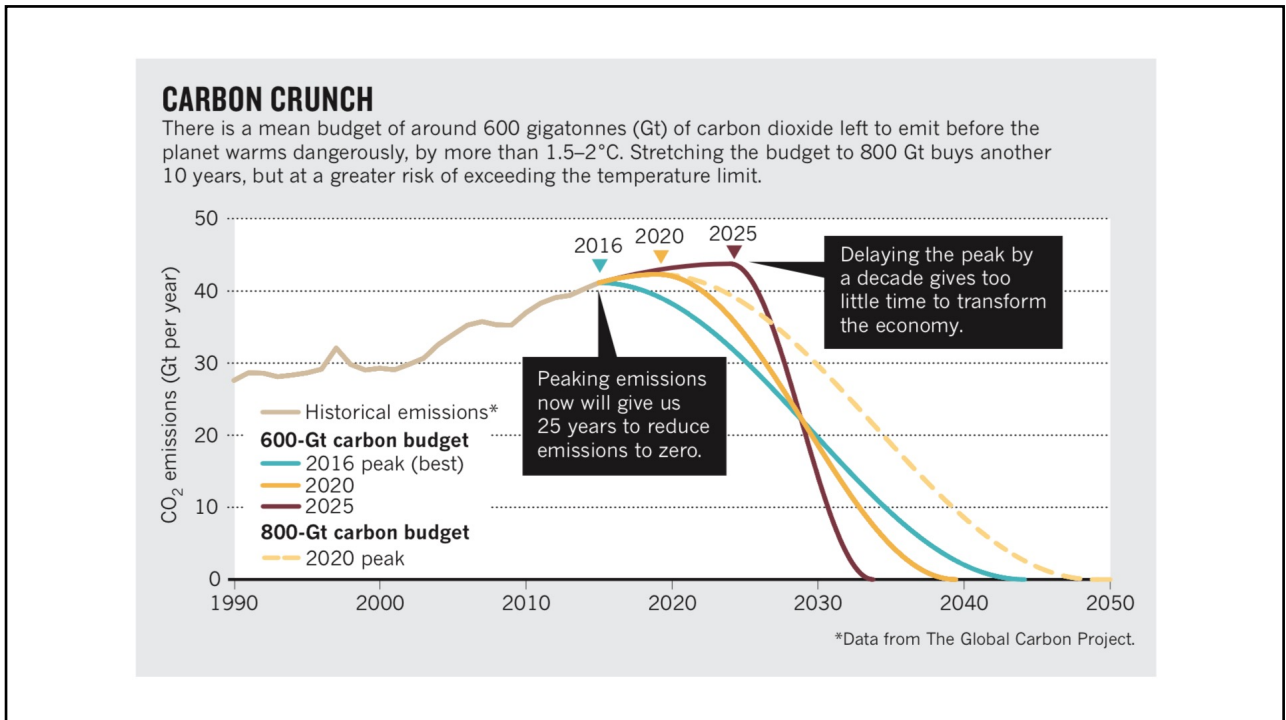


Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

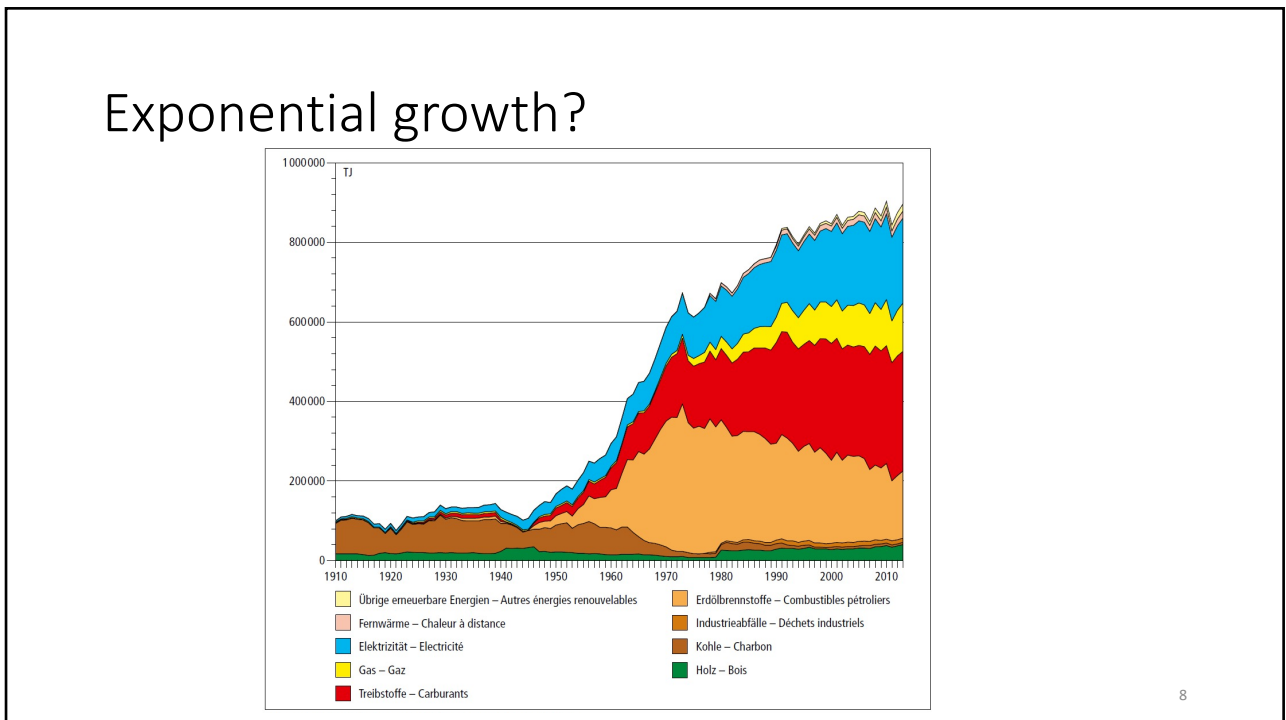
OurWorldInData.org/energy • CC BY

6

6



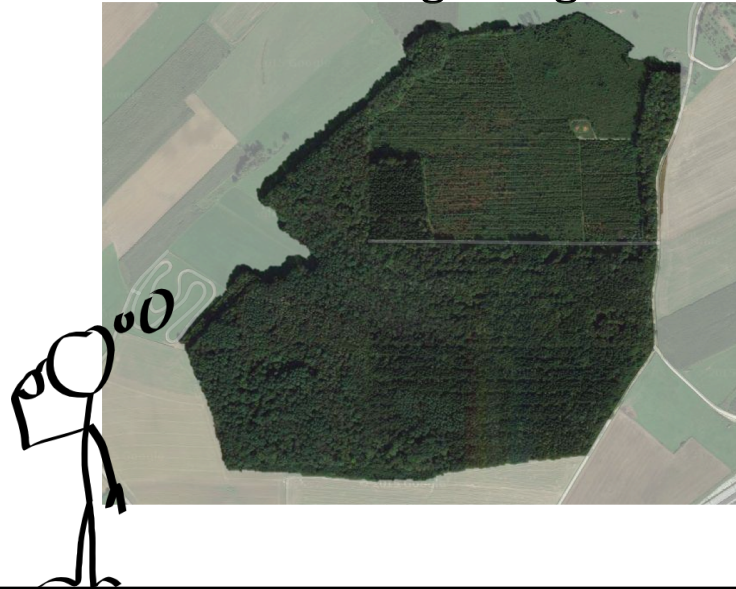
7



8



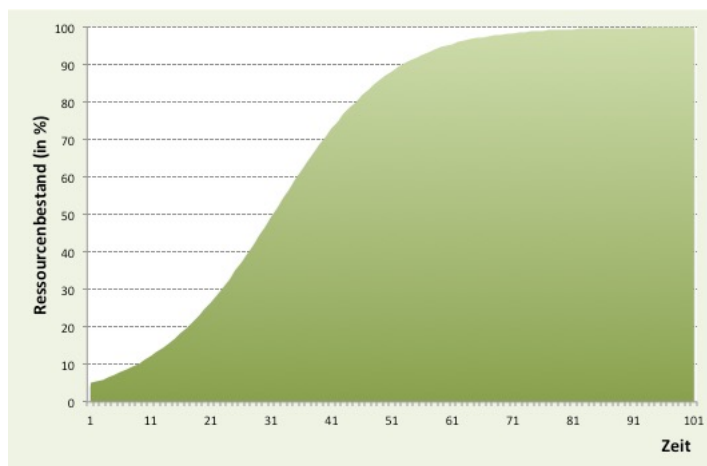
# A standard model of logistic growth



9

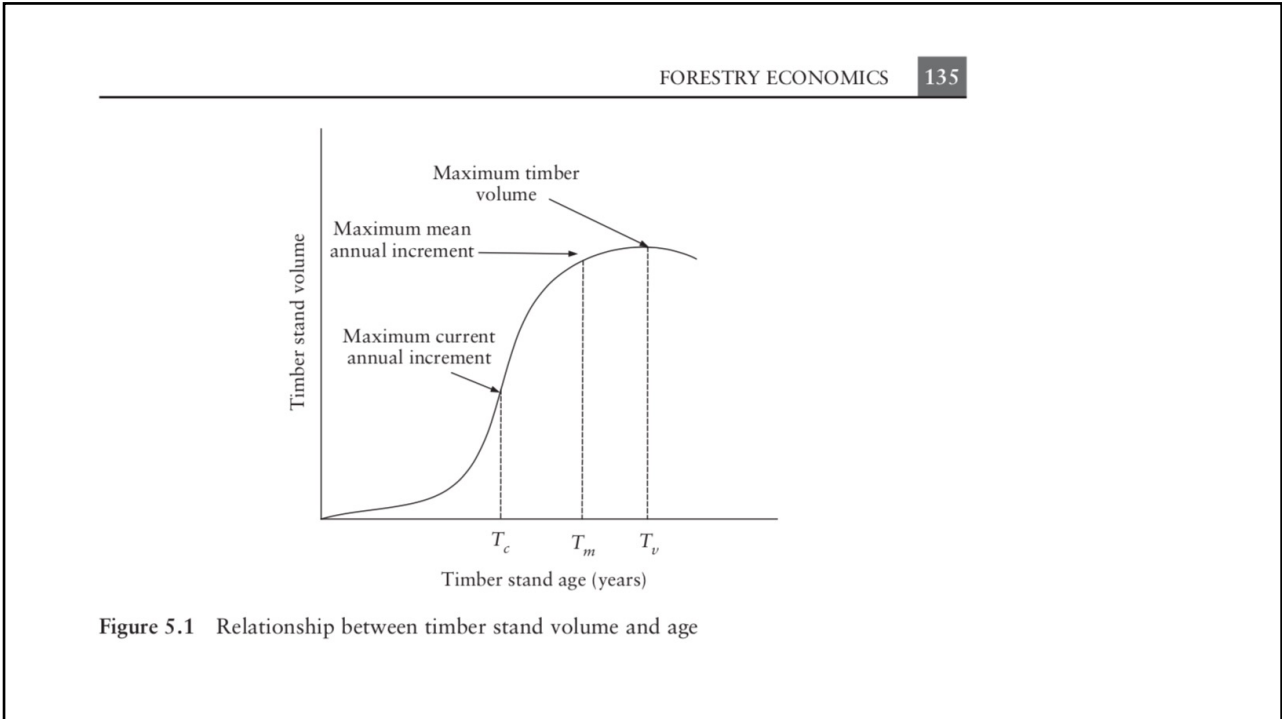
9

# A standard model of logistic growth

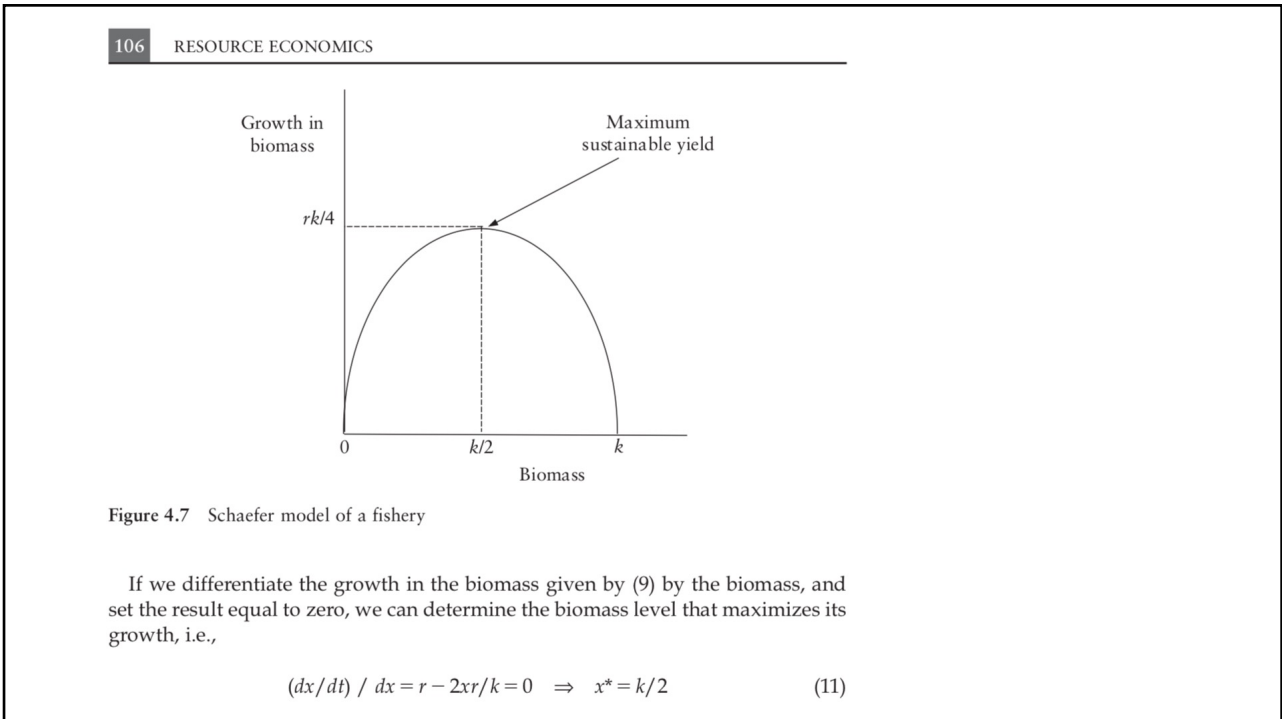


10

10



11



12

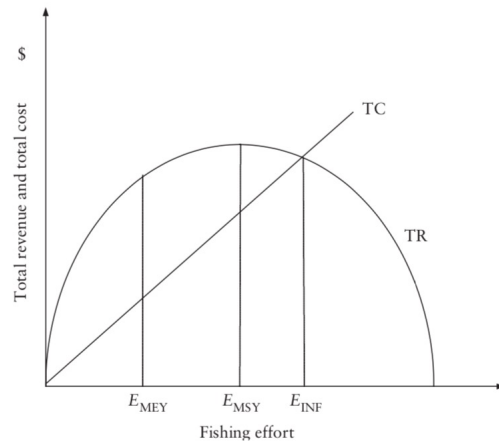


Figure 4.9 The Gordon-Schaefer model (sustained yield-effort)

13

## Optimal resource use

- Optimal versus stable / resilient plans
- Is Maximum Sustainable Yield (MSY) the optimal resource use?



Common beech forest

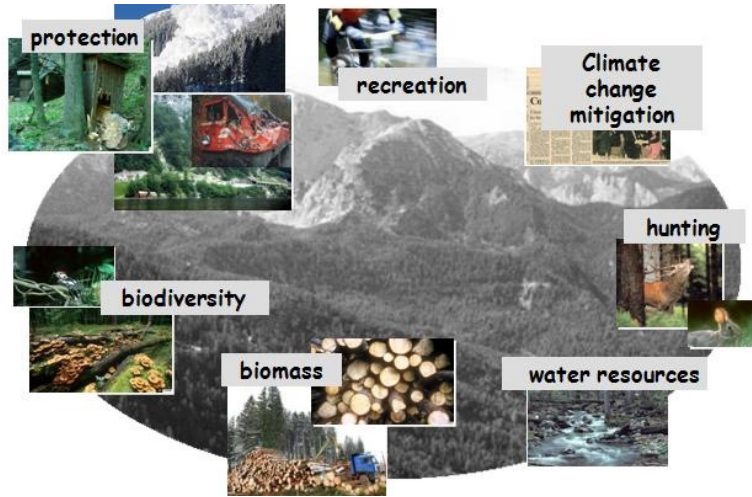


Poplar plantation Source: Lignovis GmbH

14

14

# Multifunctional resource use



15

15

# Example: Switzerland

## Forest policy law from 1876 with orders / prohibitions:

- Planning duty
- Prohibition of privatization
- Prohibition of clear cuts and order to maintain forests

Landschaftsveränderung durch Aufforstung von Schutzwald. Vergleich Tösstal 1903/1961 (Fotos E. Jäckli und E. Krebs).



16

16

# Forestry and sustainability

## German forestry in the 18th century

«*Sylvicultura oeconomica oder haußwirthliche Nachricht und Naturmäßige Anweisung zur wilden Baum-Zucht*» (1713)

**'continuirlich beständige und nachhaltende Nutzung'**



Hans Carl von Carlowitz  
1645-1714



Context: Mining and smelting led to deforestation, timber shortage, increasingly long timber transports, rising prices

=> Economic, not ecological considerations led to the demand for a different use ('suffer great need in the future'). At the same time, Carlowitz invoked the creation mandate of "preservation".

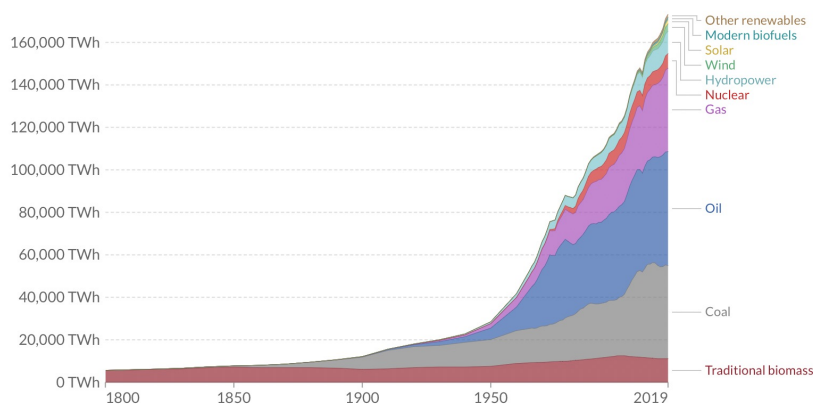
# Forest policy and biomass use

## Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.



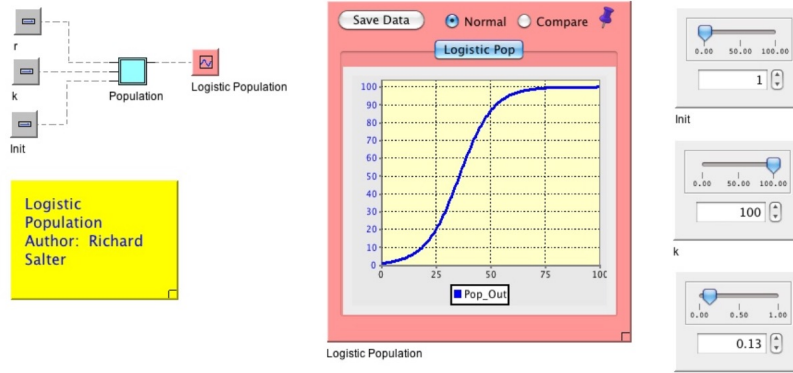
Relative



Source: Vaclav Smil (2017) & BP Statistical Review of World Energy

OurWorldInData.org/energy • CC BY

# Dynamical systems: population growth



<https://6a13c5b2fc59e0f5cc2d-504d68e748ee944d3fccba00fd5e2fd4.ssl.cf1.rackcdn.com/Logistic/index.html>