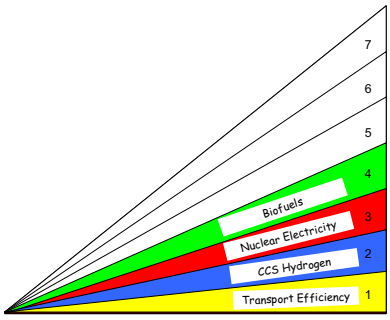
Student Game Instructions & Materials

The goal of this game is to **construct a stabilization triangle using seven wedge strategies**, with only a few constraints to guide you. From the 15 potential strategies, choose 7 wedges that your team considers the best global solutions. Keep costs and impacts in mind.

1) Find the Wedge Gameboard in the back of this packet and cut apart the red, green, yellow, and blue wedge pieces supplied (if not already done for you).

2) Read the information on each of the 15 strategies in the **Wedge Table** below. Costs ($, $$, $$$) are indicated on a relative basis, and are intended only to provide guidance, not a numerical score.



3) Each team should **choose one wedge strategy at a time** to fill the 7 spots on the wedge gameboard (see illustration of gameboard with 4 wedges filled in at left – this is only an example!).

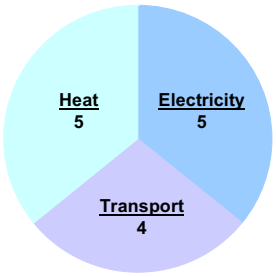
4) The four colors of the wedge pieces indicate the major category (fossil fuel-based (blue), efficiency and conservation (yellow), nuclear (red), and renewables and biostorage (green)). Choose a red, yellow, blue, or green wedge for your strategy, then **label the wedge to indicate the specific strategy** (examples shown in illustration at left).

5) Most strategies may be used more than once, but not all cuts can come from one energy sector.

Of the 14 billion tons of carbon emitted in the 2055 baseline scenario, we assume electricity production accounts for 5 wedges, transportation fuels accounts for 4 wedges, and direct fuel use for heat and other purposes accounts for 5 wedges (see pie chart right).

Because biostorage takes carbon from all sources out of the atmosphere, biostorage wedges do not count toward an energy sector.

Carbon Emissions by Sector



Need 7 wedges – not all wedges can come from one energy sector!

6) Cost and impacts must be considered. Each wedge should be viewed in terms of both technical and political viability.

7) For each of the 7 strategies chosen, each team should **fill out one line in the Wedge Worksheet**. After all 7 wedges have been chosen, tally total cuts from each energy sector (Electricity, Transport, and Heat) and costs. Use the scoring table to predict how different interest groups would rate your wedge on a scale from 1 to 5.

8) Each team should **give a 5-minute oral report** on the reasoning behind its triangle. The report should justify your choice of wedges to the judge(s) and to the other teams. **Note: There is no "right" answer** – the team that makes the best case wins, not necessarily the team with the cheapest or least challenging solution

Wedge Table

STUDENT GAME MATERIALS – Print single-sided

= Electricity Production, =Heating and Direct Fuel Use, =Transportation, = Biostorage

Strategy	Sector	Description	1 wedge could come from…	Cost	Challenges
1. Efficiency – Transport		Increase automobile fuel efficiency (2 billion cars projected in 2050)	**… doubling the efficiency of the all world's cars from 30 to 60 mpg**	**$**	Car size & power
2. Conservation - Transport		Reduce miles traveled by passenger and/or freight vehicles	**… cutting miles traveled by all passenger vehicles in half**	**$**	Increased public transport, urban design
3. Efficiency - Buildings		Increase insulation, furnace and lighting efficiency	**… using best available technology in all new and existing buildings**	**$**	House size, consumer demand for appliances
4. Efficiency – Electricity		Increase efficiency of power generation	**… raising plant efficiency from 40% to 60%**	**$**	Increased plant costs
5. CCS Electricity		CO_2 from fossil fuel power plants captured, then stored underground (700 large coal plants or 1400 natural gas plants)	**… injecting a volume of CO_2 every year equal to the volume of oil extracted**	**$$**	Possibility of CO_2 leakage
6. CCS Hydrogen		Hydrogen fuel from fossil sources with CCS displaces hydrocarbon fuels	**… producing hydrogen at 10 times the current rate**	**$$$**	New infrastructure needed, hydrogen safety issues
7. CCS Synfuels		Capture and store CO_2 emitted during synfuels production from coal	**… using CCS at 180 large synfuels plants**	**$$**	Emissions still only break even with gasoline
8. Fuel Switching – Electricity		Replacing coal-burning electric plants with natural gas plants (1400 1 GW coal plants)	**… using an amount of natural gas equal to that used for all purposes today**	**$**	Natural gas availability
9. Nuclear Electricity		Displace coal-burning electric plants with nuclear plants (2 x current capacity)	**… ~3 times the effort France put into expanding nuclear power in the 1980's, sustained for 50 years**	**$$**	Weapons proliferation, nuclear waste, local opposition
10. Wind Electricity		Wind displaces coal-based electricity (30 x current capacity)	**… using area equal to ~3% of U.S. land area for wind farms**	**$$**	Not In My Back Yard (NIMBY)
11. Solar Electricity		Solar PV displaces coal-based electricity (700 x current capacity)	**.. using the equivalent of a 100 x 200 km PV array**	**$$$**	PV cell materials
12. Wind Hydrogen		Produce hydrogen with wind electricity	**… powering half the world's cars predicted for 2050 with hydrogen**	**$$**	NIMBY, Hydrogen infrastructure, safety
13. Biofuels		Biomass fuels from plantations replace petroleum fuels	**… scaling up world ethanol production by a factor of 30**	**$$**	Biodiversity, competing land use
14. Forest Storage		Carbon stored in new forests	**… halting deforestation in 50 years**	**$**	Biodiversity, competing land use
15. Soil Storage		Farming techiques increase carbon retention or storage in soils	**… using conservation tillage on all the world's agricultural soils**	**$**	Reversed if land is deep-plowed later

Wedge Worksheet

1. Record your strategies to reduce total fossil fuel emissions by 7 wedges by 2055
(1 "wedge" = 1 billion tons carbon per year)

- You may use a strategy more than once
- Use only whole numbers of wedges
- You may use a maximum of
  - 5 electricity wedges (E)
  - 4 transportation wedges(T)
  - 5 heat or direct fuel use wedges (H)

Wedge #	Strategy	Sector E, T, H, or B	Cost $	Challenges
1				
2				
3				
4				
5				
6				
7				
	TOTALS	E = ___ (5 max) T = ___ (4 max) H = ___ (5 max) B = ___	_____	

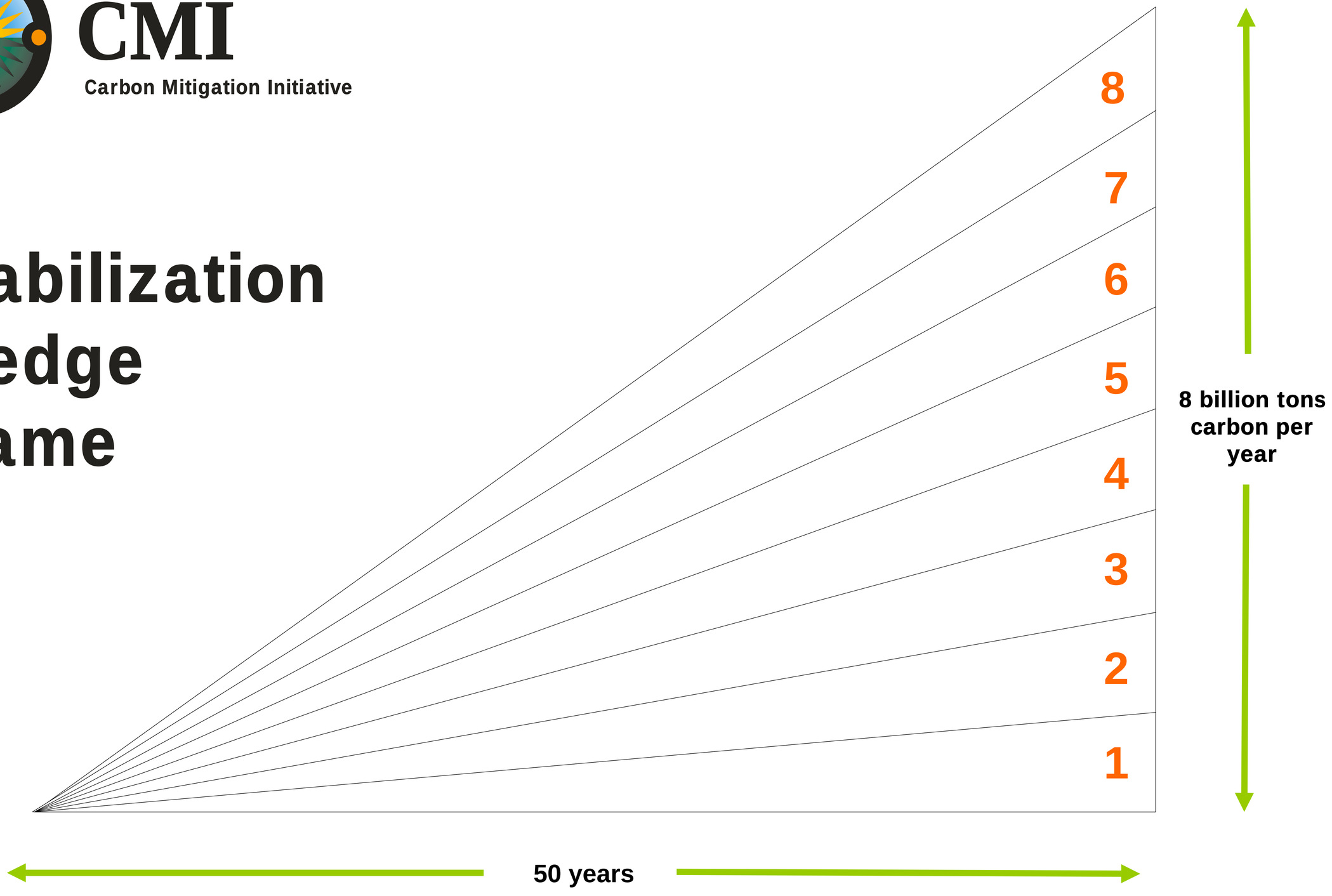
2. Guess the score each stakeholder group would give your team's triangle on a scale of 1 to 5 (5 = best).

Judge:	Taxpayers/ Consumers	Energy Companies	Environmental Groups	Manufacturers	Industrialized country governments	Developing country governments
Score:						

CMI

Carbon Mitigation Initiative

Stabilization Wedge Game



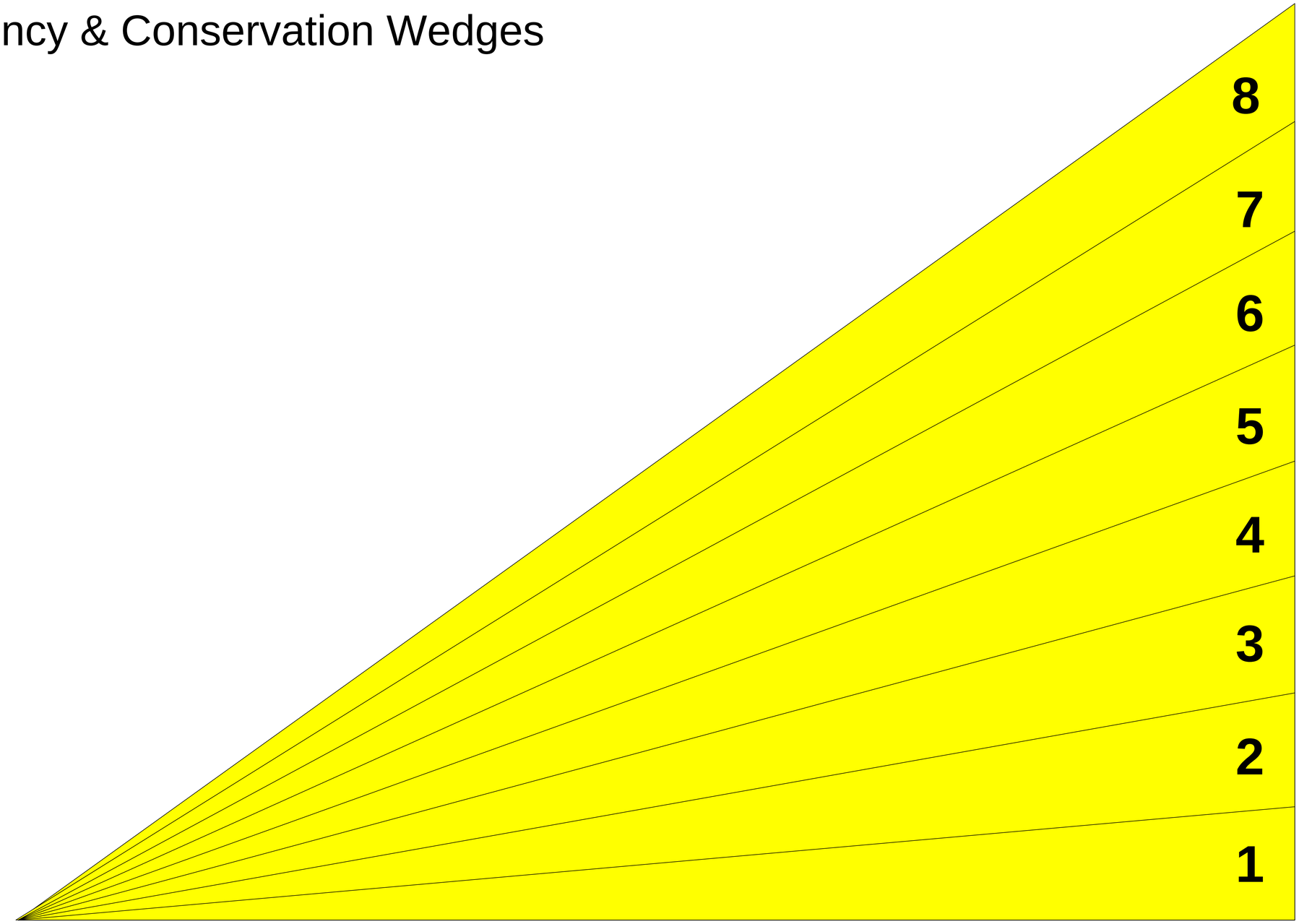
PEI Princeton Environmental Institute

Princeton University

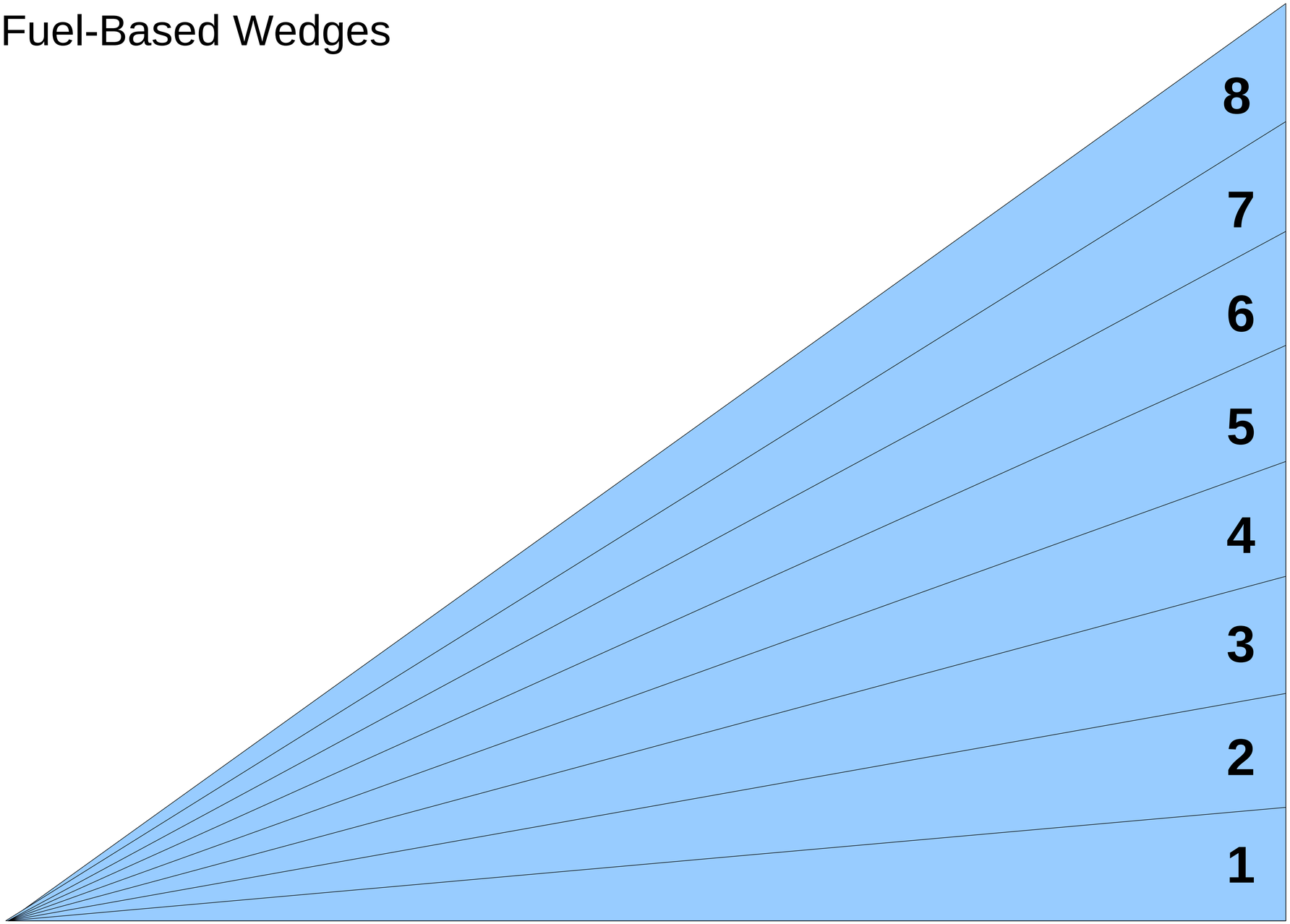
bp

Ford

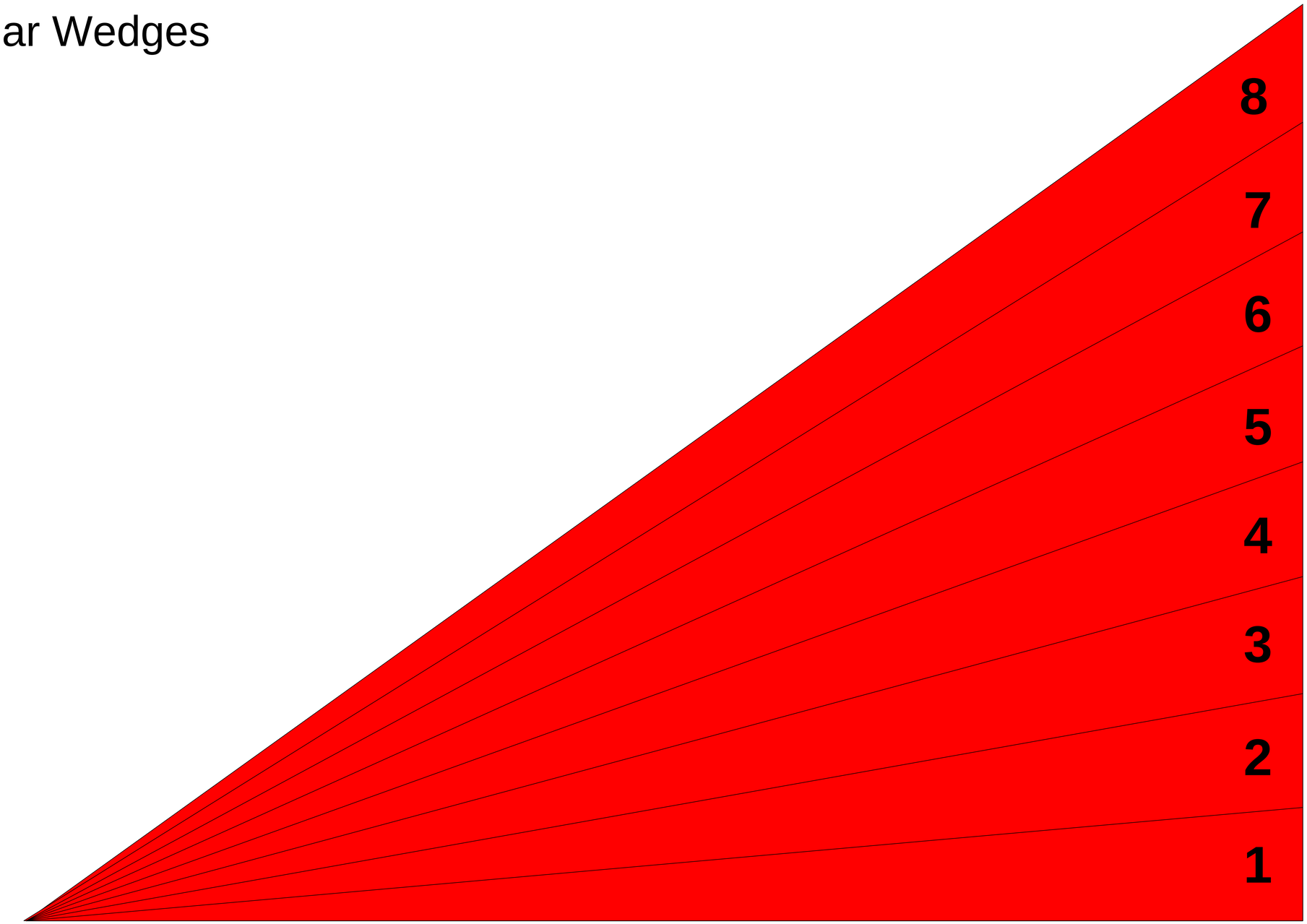
Efficiency & Conservation Wedges



Fossil-Fuel-Based Wedges



Nuclear Wedges



Renewables & Conservation Wedges