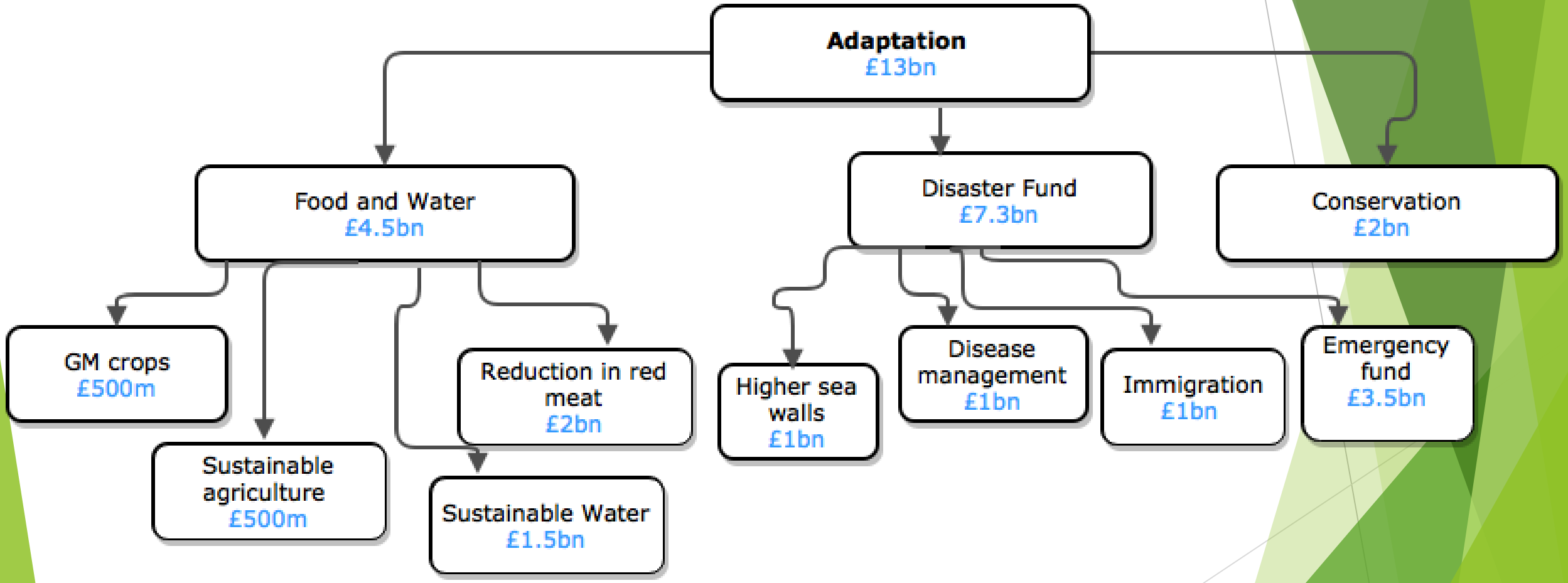
Climate Budget: The £100bn Question

Introduction

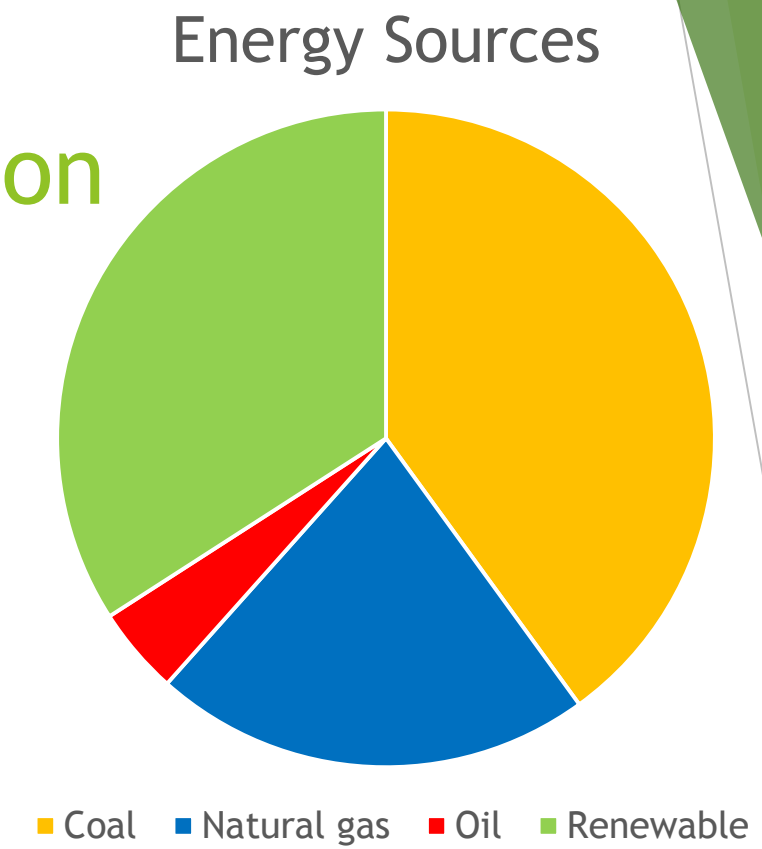
- We have been given £100bn to solve climate change
- We divided up the money to be used in 4 areas:
  - Adaptation - £13bn
  - Energy - £30bn
  - Transport - £27bn
  - Geoengineering - £30bn

Adaptation - £13bn



Energy - £30bn

Global Electricity Production



- 40% Coal
- 21.6% Natural Gas
- 4.3% Oil
- 34.1% Renewable (Nuclear, Hydro, Wind, Solar)

- According to IEA (International energy agency), Humans use 1.25×10^{13} Joules per second.

- Our Goal is 100% renewable energy

IEA 2014

Solar Arrays

- 50 KW solar arrays can currently be bought at £74,000, and can return a £10,000 profit annually.
- Price of energy from Photovoltaic solar cells has halved between 2010 and 2015.
- Due to drop 10% in price every year for the foreseeable future

Ecoexperts.co.uk, IRENA 2016

Our Model

- We had a budget of $30bn and decided to spend it on Solar Arrays
- We created a long term model which had the following assumptions:
- Solar arrays would fall in price by 10%
- This would occur for the next 12 years until the price fell to below 30% of today's cost
- All returns invested back into more solar panels

Financial Times

$$P_G = P_i \left(1 + \sum_{n=1}^{12} \frac{1.14^n - 1}{0.9^n} + \sum_{n=13}^{N} \frac{1.14^n - 1}{0.9^{12}}\right)$$

Global power consumption 2014 (IEA)

Initial solar array power output

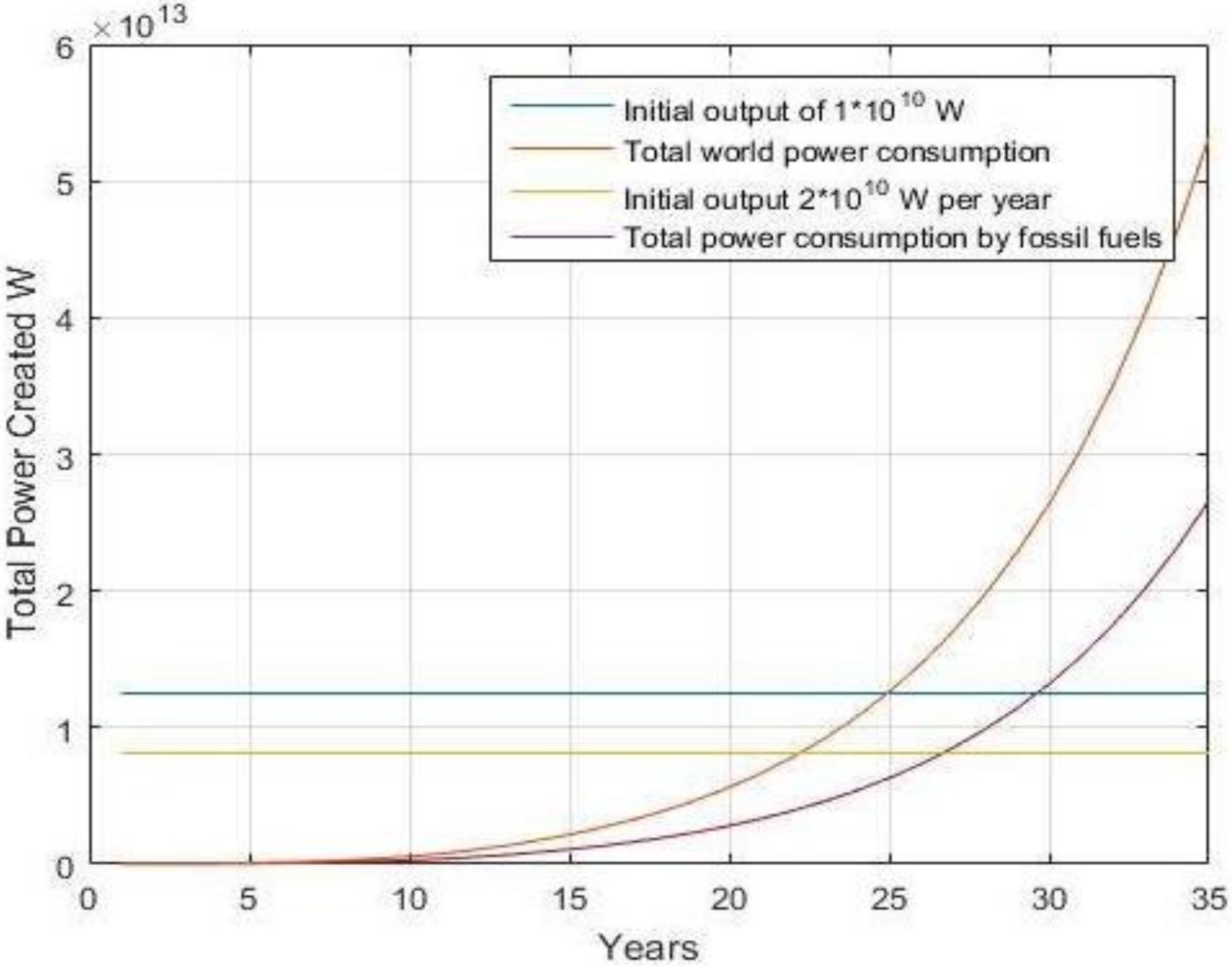
Additional power output from years 1 to 12 based on price drop and reinvestment

Additional power output from year 13 onwards until we meet the target based on reinvestment

$P_G = 1.25 \times 10^{13}$ W

$P_i = 2.0 \times 10^{10}$ W

N = total number of years to provide P_G



Integrated under the blue curve between 0 and 35 years to find the total energy produced to be:

1.56×10^9 GWh

Which produces:

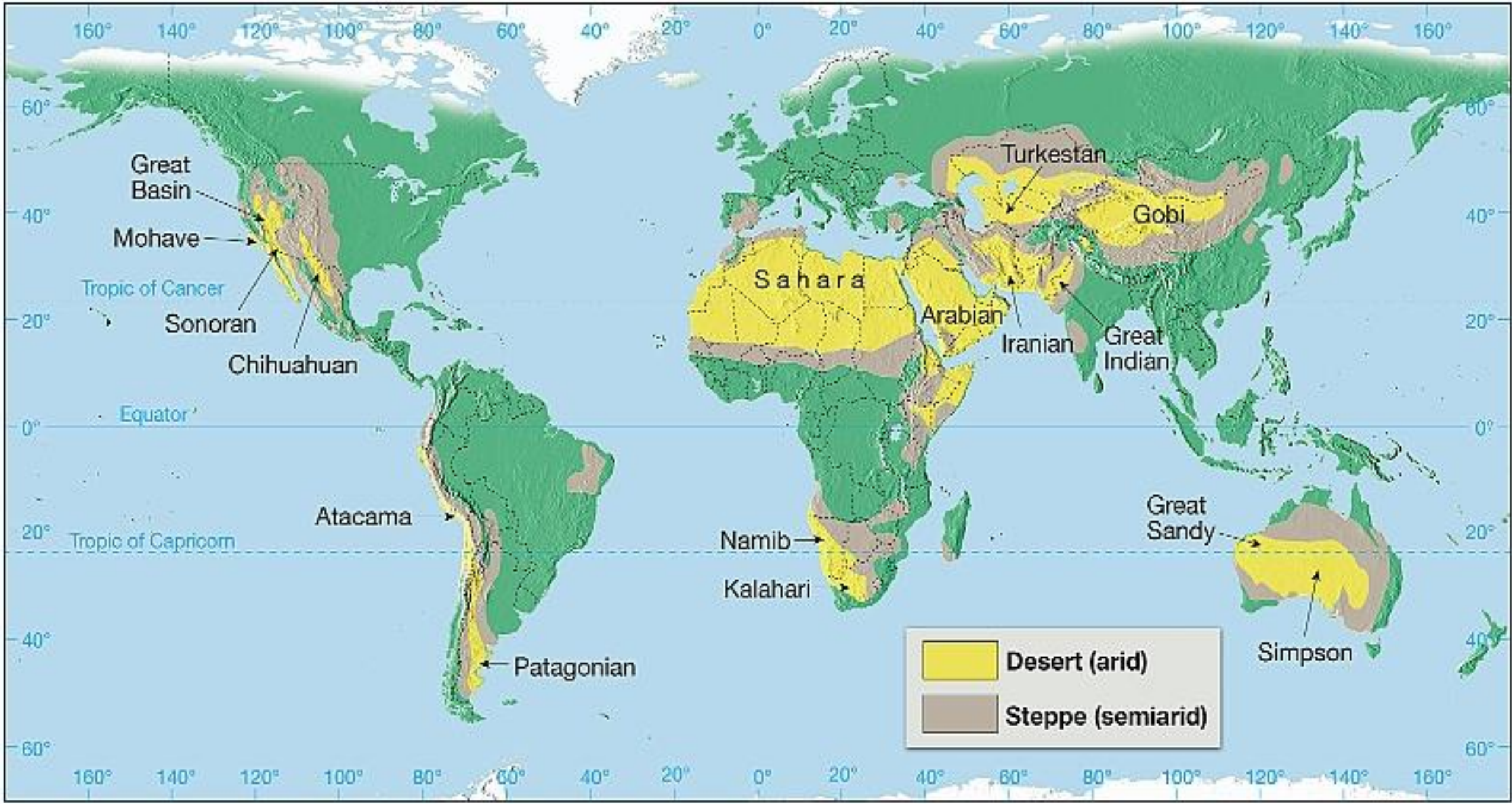
60 Gt of CO_2 over 35 years

Adjustments and inaccuracies

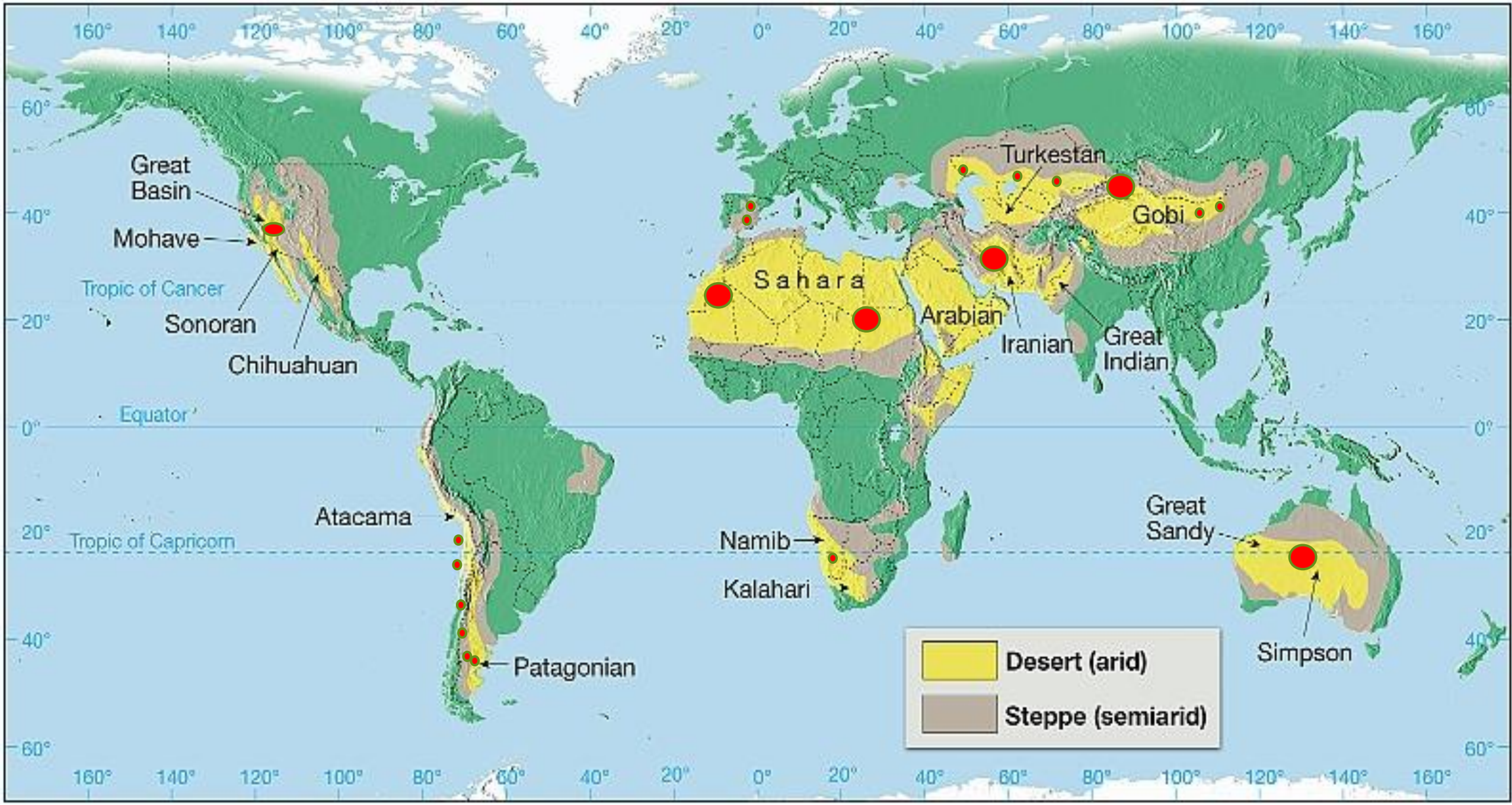
- We modelled for the panels working 24hr and 12hr a day to allow for them not producing energy at night
- Doesn’t account for weather
- Doesn’t account for market fluctuations
- Doesn’t account for bulk buying or subsidies
- Doesn’t account for storage, guarding and maintenance

Limitations

- Exponential growth is currently unsustainable
- Political barriers
- Labour
- Transport
- Carbon Footprint



Pearson Prentice Hall Inc



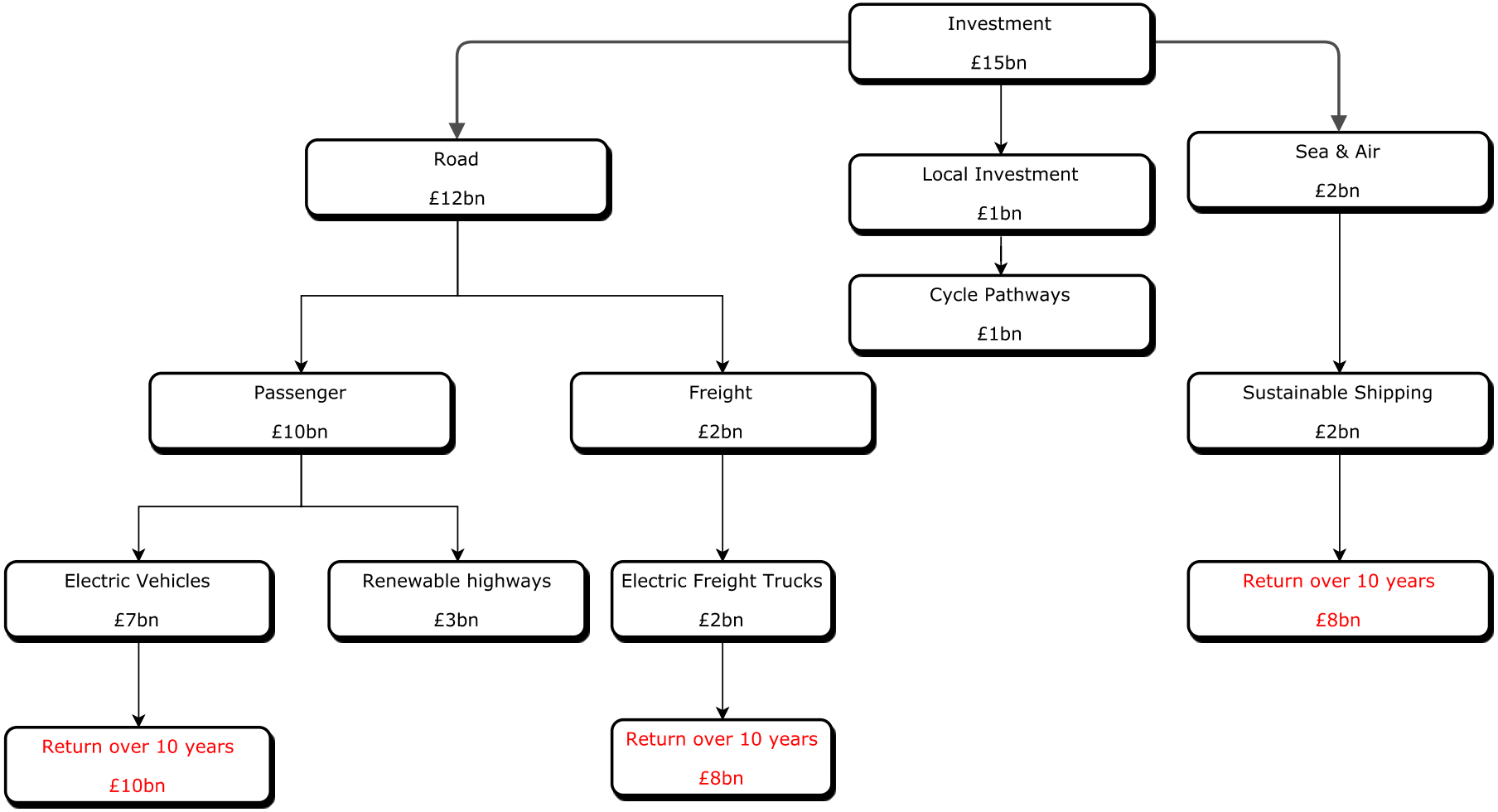
Pearson Prentice Hall Inc

Transport - £27bn

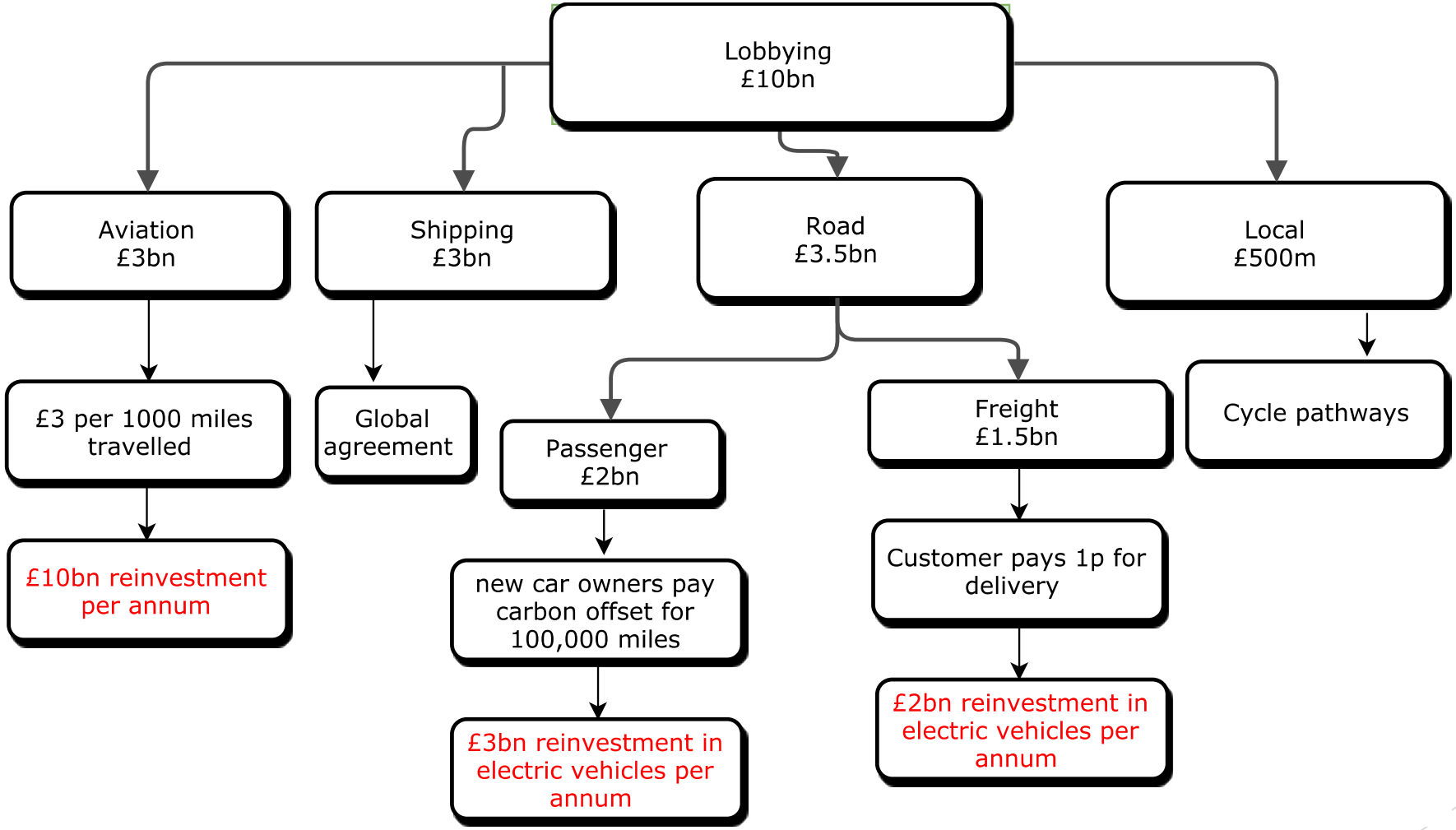
Transport

- Alongside energy, transport is the driving force behind the global economy
- Transport is responsible for 20% of the global CO_2 emissions
- Multiple co-benefits from investment

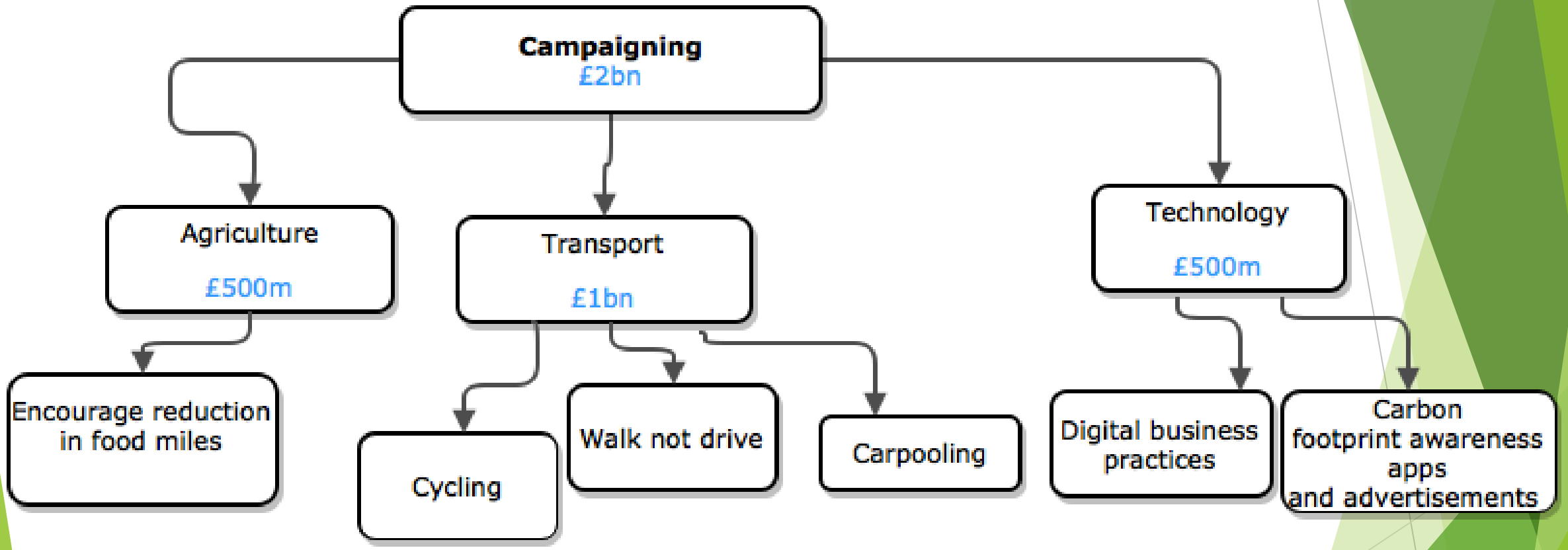
Technology investment £15bn



Lobbying £10bn



Campaigning £2bn



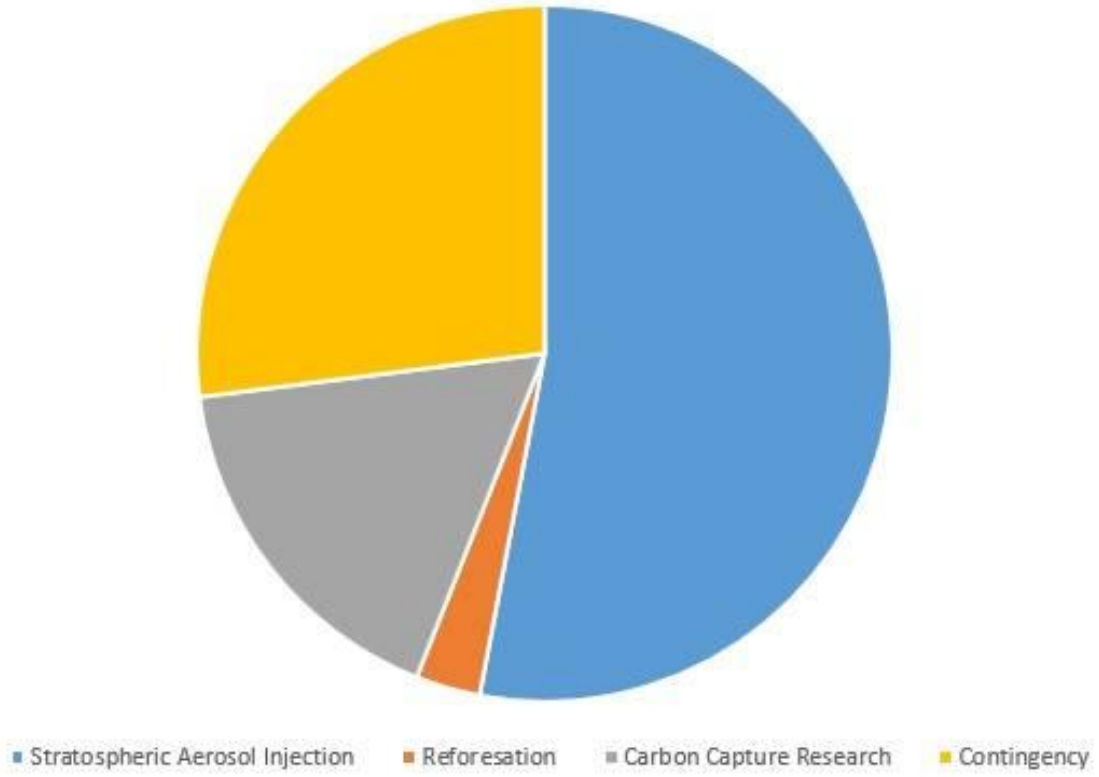
Geoengineering - £30bn

What is geoengineering?

"Is the deliberate large-scale intervention in the Earth's climate system to counteract the effects of anthropengic climate change"

1. Solar Radiation Management
2. Carbon Dioxide Removal

Splitting up our £30 billion:



- £16 bn: Stratospheric Aerosol Injection
- £8 bn: Contingency
- £5 bn: Research into Carbon Capture
- £1 bn: Reforestation

Stratospheric Aerosol Injection

- SRM is predicted to quickly stop the rise in global temperatures and the cool the planet.
- Inject Sulphur Dioxide into Stratosphere
- Bright particles, reflects fraction of incoming solar radiation
- Increasing planetary albedo
- Decrease in global temperatures
- Note: CO2 concentrations are not reduced

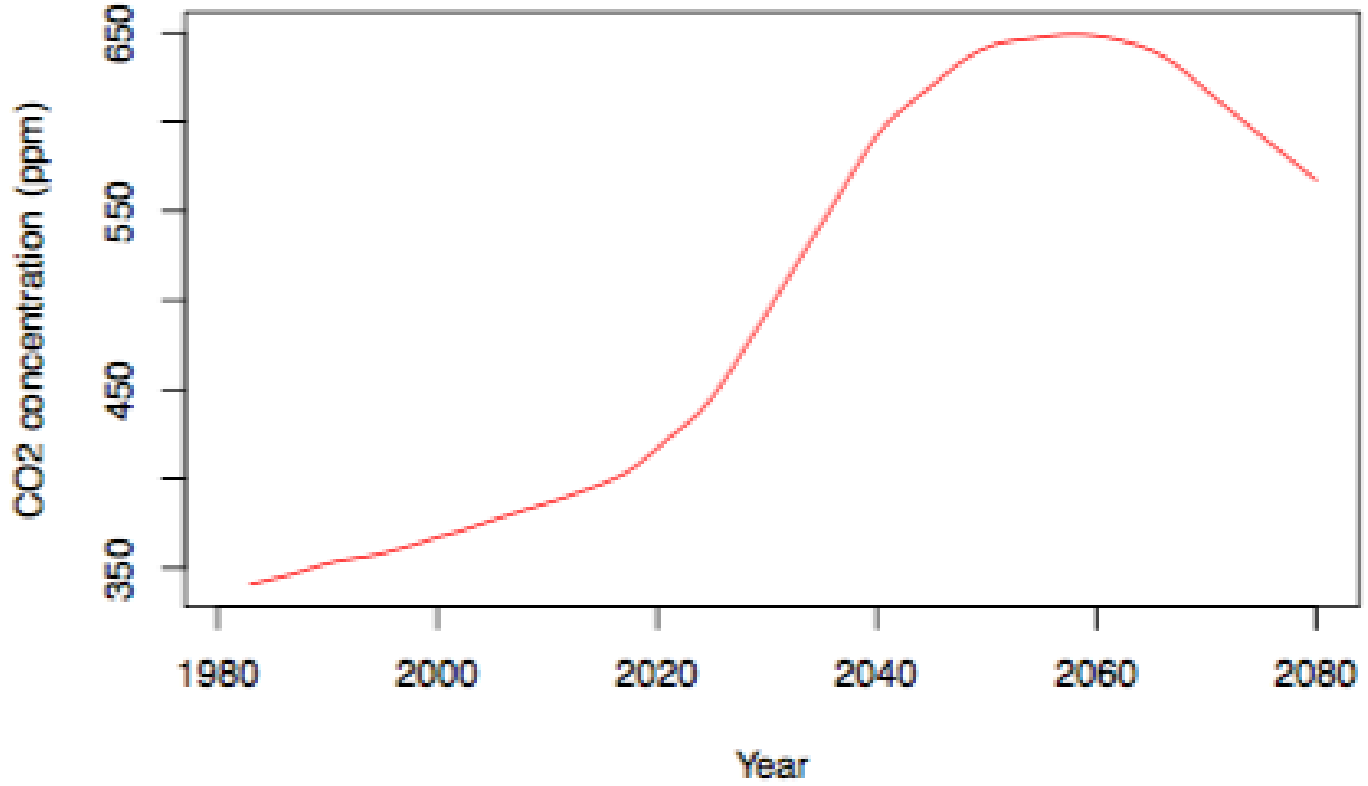
Simplified Radiative Forcing Calculations

Climate Forcing:
An energy imbalance imposed on the climate system either naturally or by human activities.

Carbon Dioxide: $\Delta Q(t) = 5.35 \ln\{ C(t)/C(0) \}$

Where, ΔQ is the radiative forcing (W m-2) arising from an increase in the atmospheric CO2 concentration from C(0) (pre-industrial) to C(t) (peak concentrations).

Predicted Cumulative CO2 Concentrations for our Scenario




```
z <- read.table("co2.txt",header = TRUE)
SCO=SMA(z[,2], n=3) ## Smooths the curve
plot(z[,1],SCO, xlab='Year',ylab='CO2 concentration (ppm)' , type='l', col=2)
```

Simplest Linear Climate Model

Global warming, ΔT (K), due to radiative forcing, ΔQ :

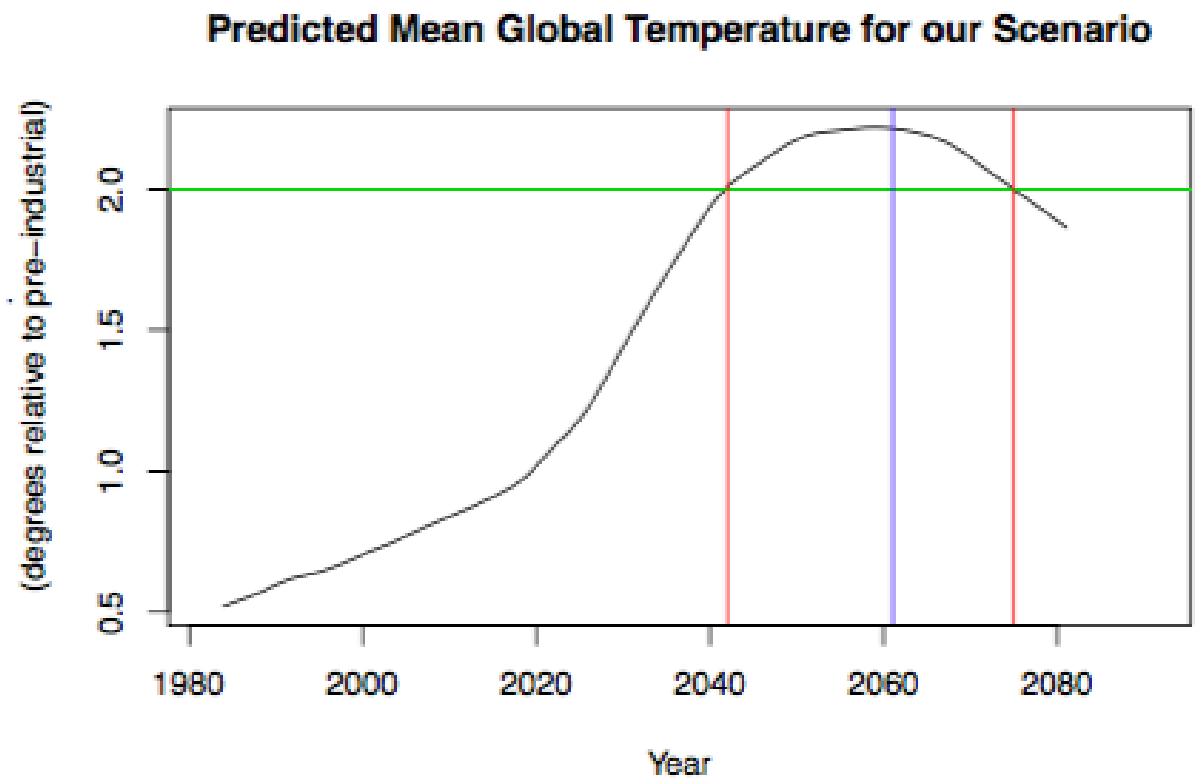
$$C\,(d\,\Delta T/dt) + \lambda\,\Delta T = \Delta Q$$

Where, ΔQ depends on the changing concentrations of greenhouse gases, aerosols and natural factors.

Derived equation:

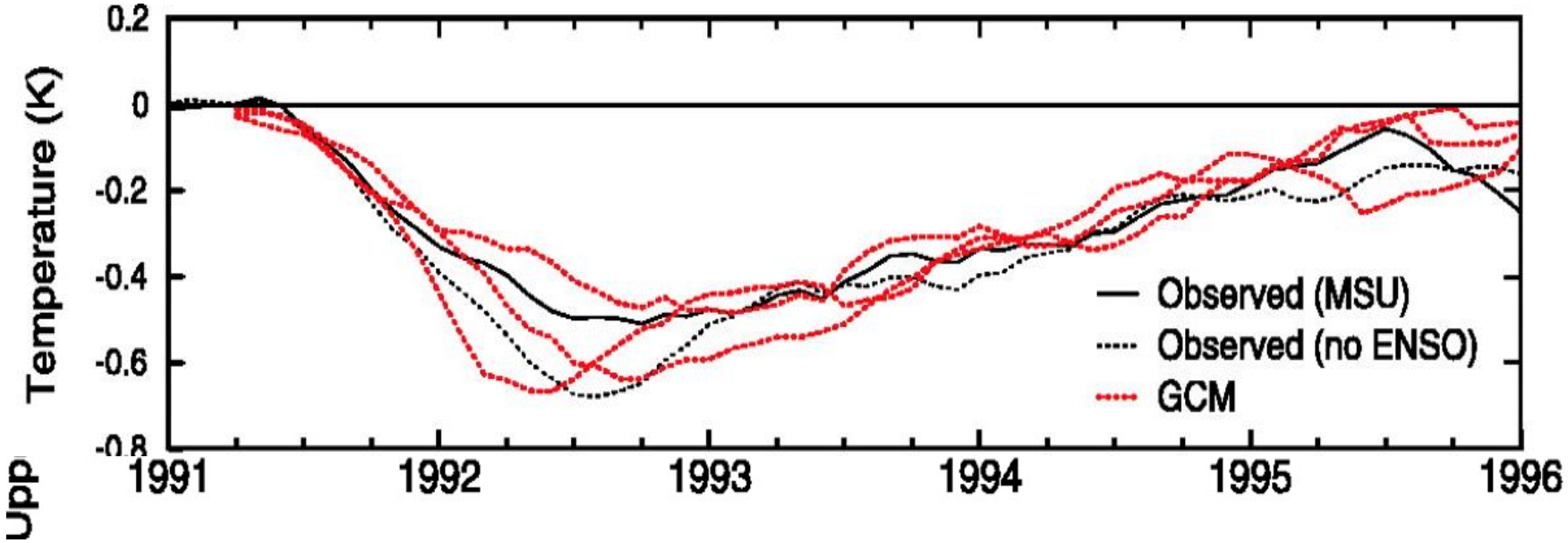
$$T = T0 + \lambda \log2\{\, C(t)/C(0) \,\}$$

Where, $T0 = 0$, as considering relative to pre-industrial temperature

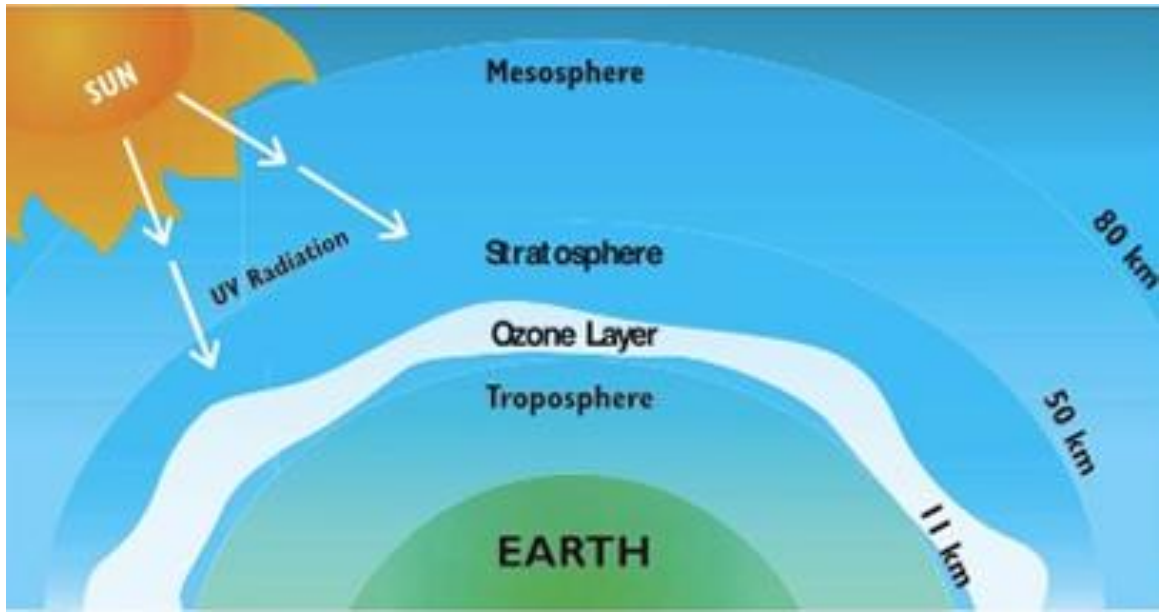



```
T=matrix(data=NA, nrow=110, ncol=2)
for (k in 1:110)
{
  T[k,1]=k+1981
  T[k,2]=1.83*log2(SCO[k]/280)
}
plot(T, xlab='Year', ylab='Mean Global Temperature
     (degrees relative to pre-industrial)', main='Predicted Mean Global Temperature for our Scenario',
abline(2.0,0,col=3)
abline(v=2042,col=2)
abline(v=2061,col=4)
abline(v=2075,col=2)
```

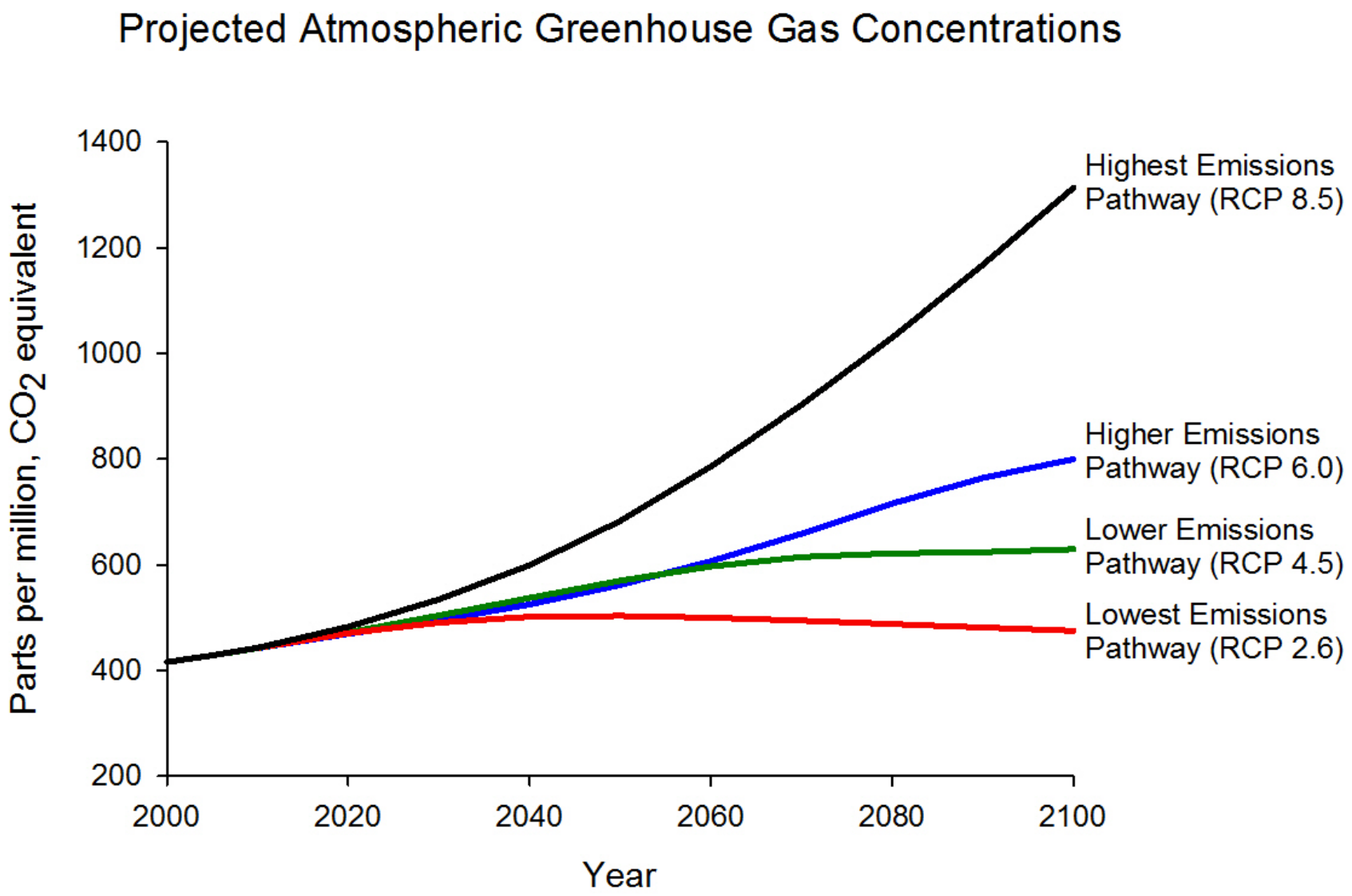
Mount Pinatubo



Layers of our atmosphere




Polar stratospheric cloud


Projected Atmospheric Greenhouse Gas Concentrations
Parts per million, CO_2 equivalent
1400
1200
1000
800
600
400
200
2000
2020
2040
2060
2080
2100
Year
Highest Emissions Pathway (RCP 8.5)
Higher Emissions Pathway (RCP 6.0)
Lower Emissions Pathway (RCP 4.5)
Lowest Emissions Pathway (RCP 2.6)

Reforestation

Carbon Capture and Storage

- £5 billion into research
- Example of Carbon Dioxide Removal
- Use to reduce Carbon Dioxide levels in the atmosphere
- Low risk as this method addresses the primary cause of climate change
- Currently expensive, so considering for possible future use

Conclusion

- The Earth’s Climate System is complex natural phenomena that cannot be solved by one simple solution
- We must adapt to our future climate, we must mitigate the negative consequences and try to reduce the damage already caused
- Only by all these pieces working together can we create the whole picture
- Greener world for a brighter future