



# The Worldwide Distribution of Solar Resources by Nation

by

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Act on Climate

# Acknowledgements

Firstly, I apologise that I am no doubt preaching to the converted but I am really seeking affirmation off these results.

Let me first please acknowledge the quality research of  
(in alphabetical order)

- Monique Hoogwijk
- Graeme Pearman
- Franz Trieb
- Bert de Vriesa
- Detlef van Vuuren and many, many others,

Plus all the people involved in the -

IIASA Global Energy Assessment, Global Atlas (IRENA), UNEP IRP, DLR MED-CSP, REN21, UNDP World Energy Assessment, again to name just a few.

But all this research seemed to come from a slightly different angle to mine, as a macroeconometrician

# Data Sources

- NASA Surface Meteorology and Solar Energy (SSE) Data†
- GeoNames Database founded by Marc Wick ([marc@geonames.org](mailto:marc@geonames.org)), a project of Unxos GmbH, Switzerland.
- Central Intelligence Agency World Factbook
- Google Maps, World Atlas, etc

## Data

Solar Radiation (Insolation) at ground level in kWh/m<sup>2</sup>/day; 22-year Annual Average (July 1983 - June 2005); average over each one degree latitude by one degree longitude (not point data); 64,800 (180x360) data points measured by satellite.

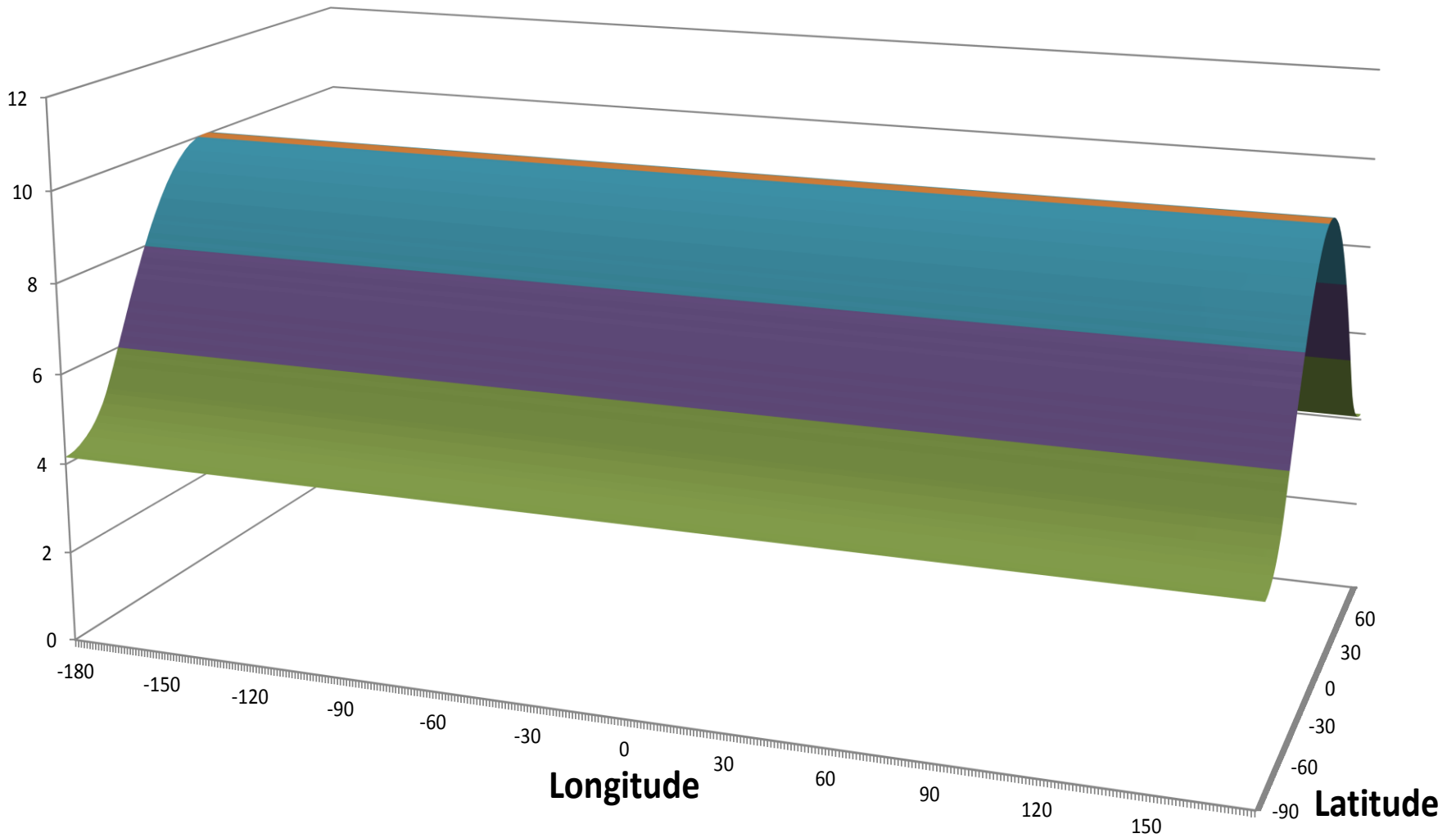
†Obtained from the NASA Langley Research Center Atmospheric Science Data Center Surface meteorological and Solar Energy (SSE) web portal supported by the NASA LaRC POWER Project.

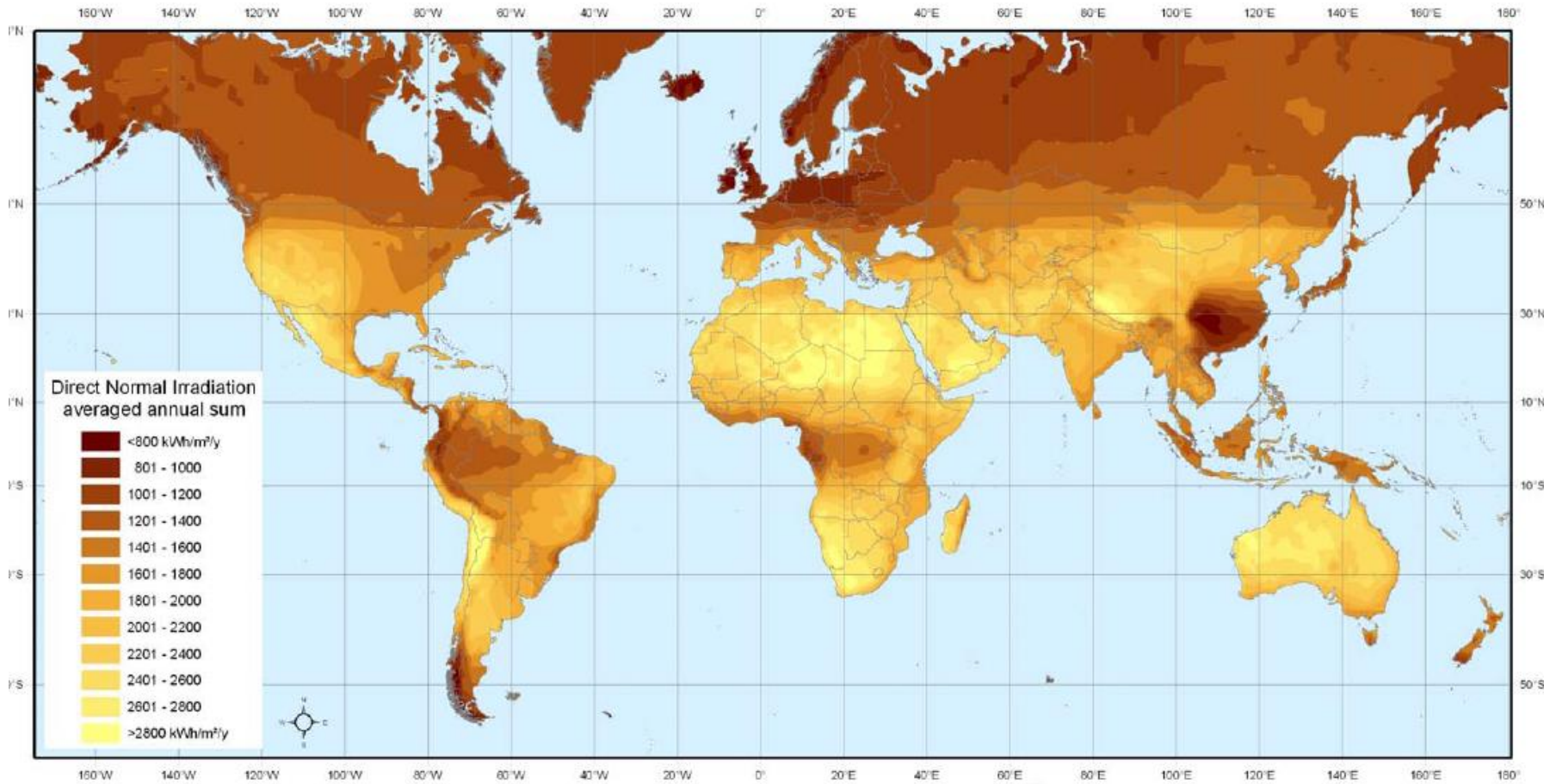
# Distinctions not made

- Different Layers of potential
  - Theoretical
  - Geographic
  - Technical
  - Economic
  - Implementation
- Just talking of Total Solar Radiation (Insolation)

# 1. At the Top of the Atmosphere

(same shape from North or South)





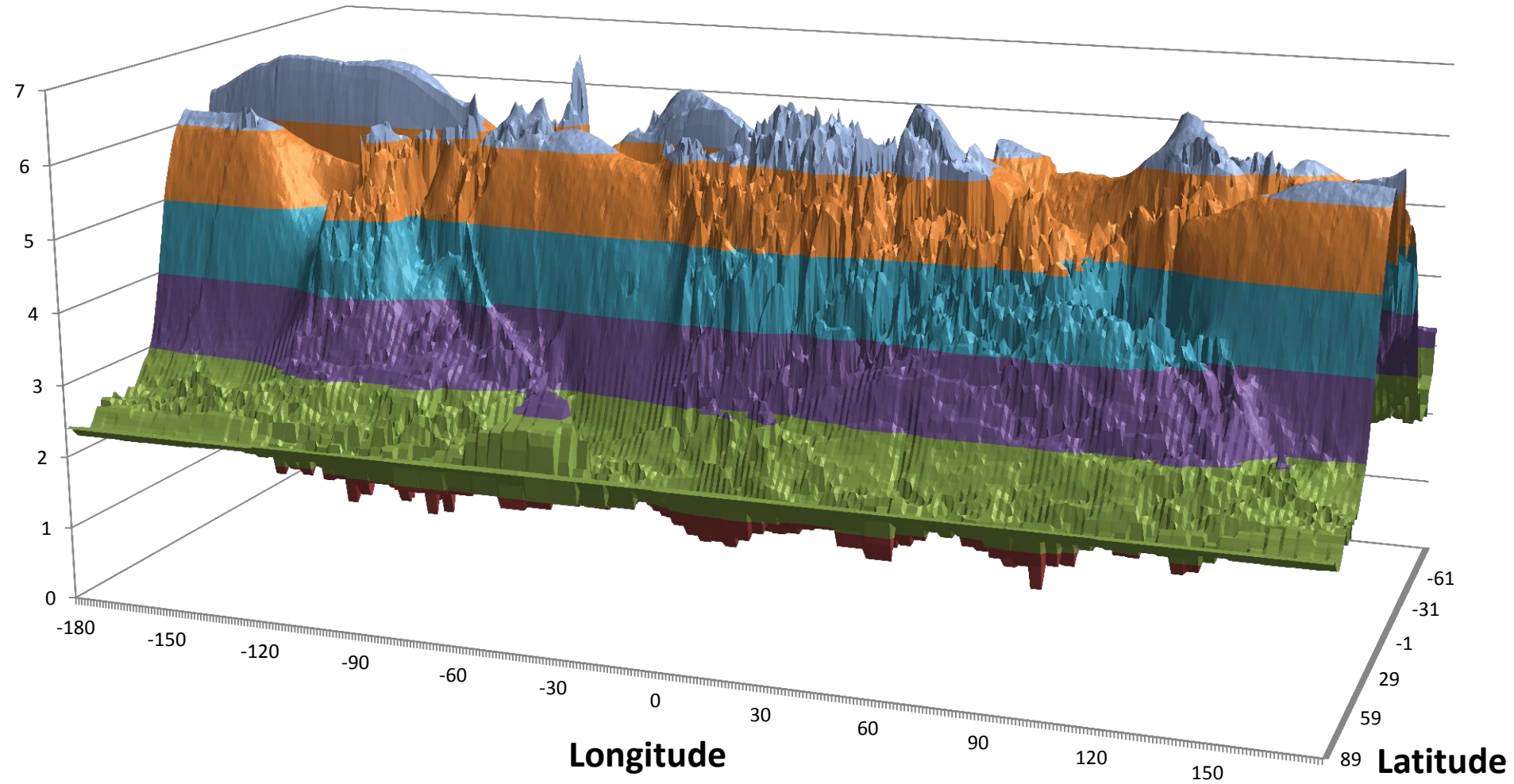
## “Solar Energy Resource Assessment: Direct Normal Irradiation”

Source: Franz Trieb, Christoph Schillings, Marlene O’Sullivan, Thomas Pregger, Carsten Hoyer-Klick (2009) , “Global Potential of Concentrating Solar Power”

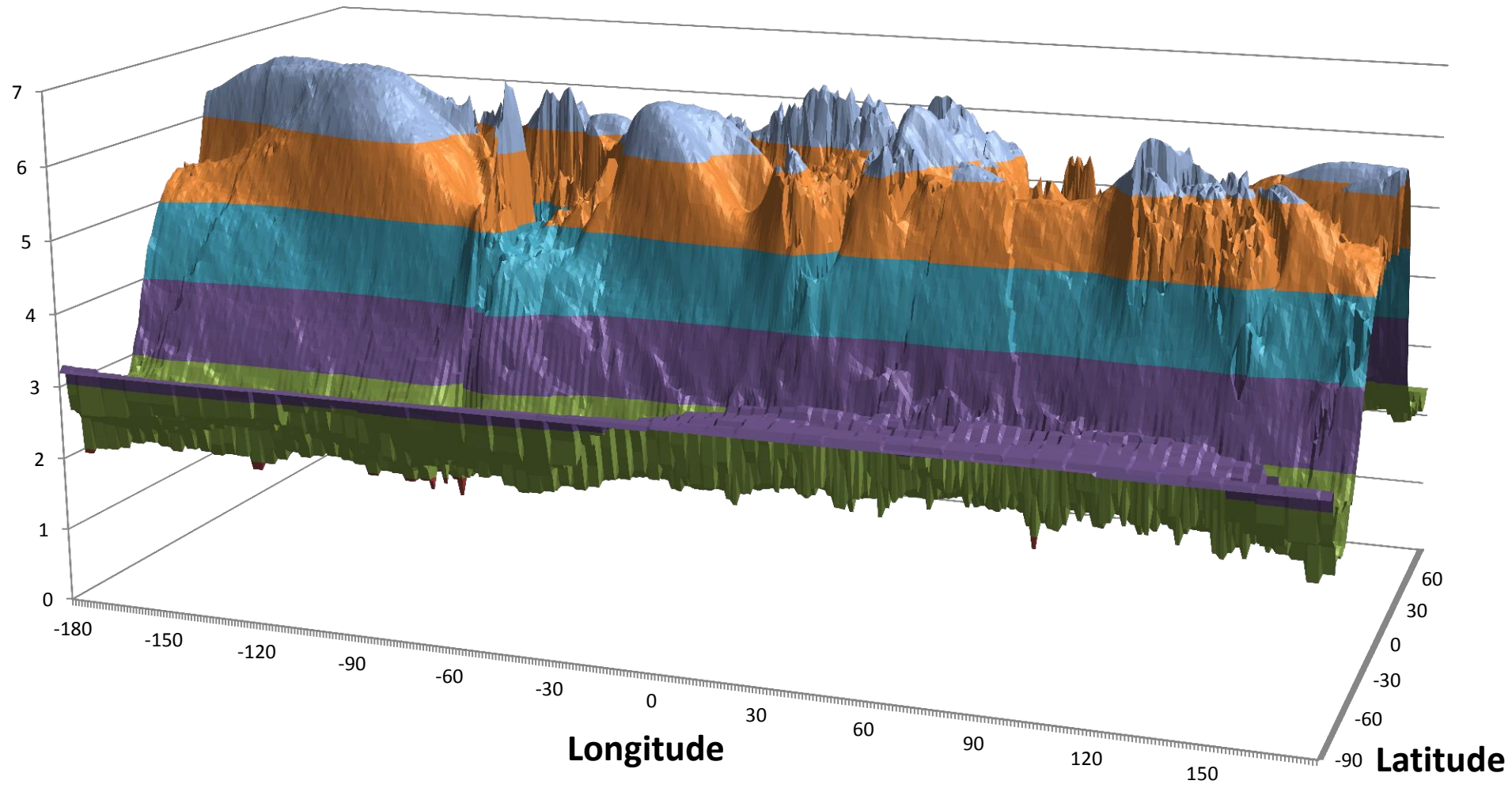
Then excludes land due to land use, water, dunes, national parks, etc. CSP for Mediterranean Countries looks in detail at 25 countries.

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## 2. Solar Insolation At Ground level from North side

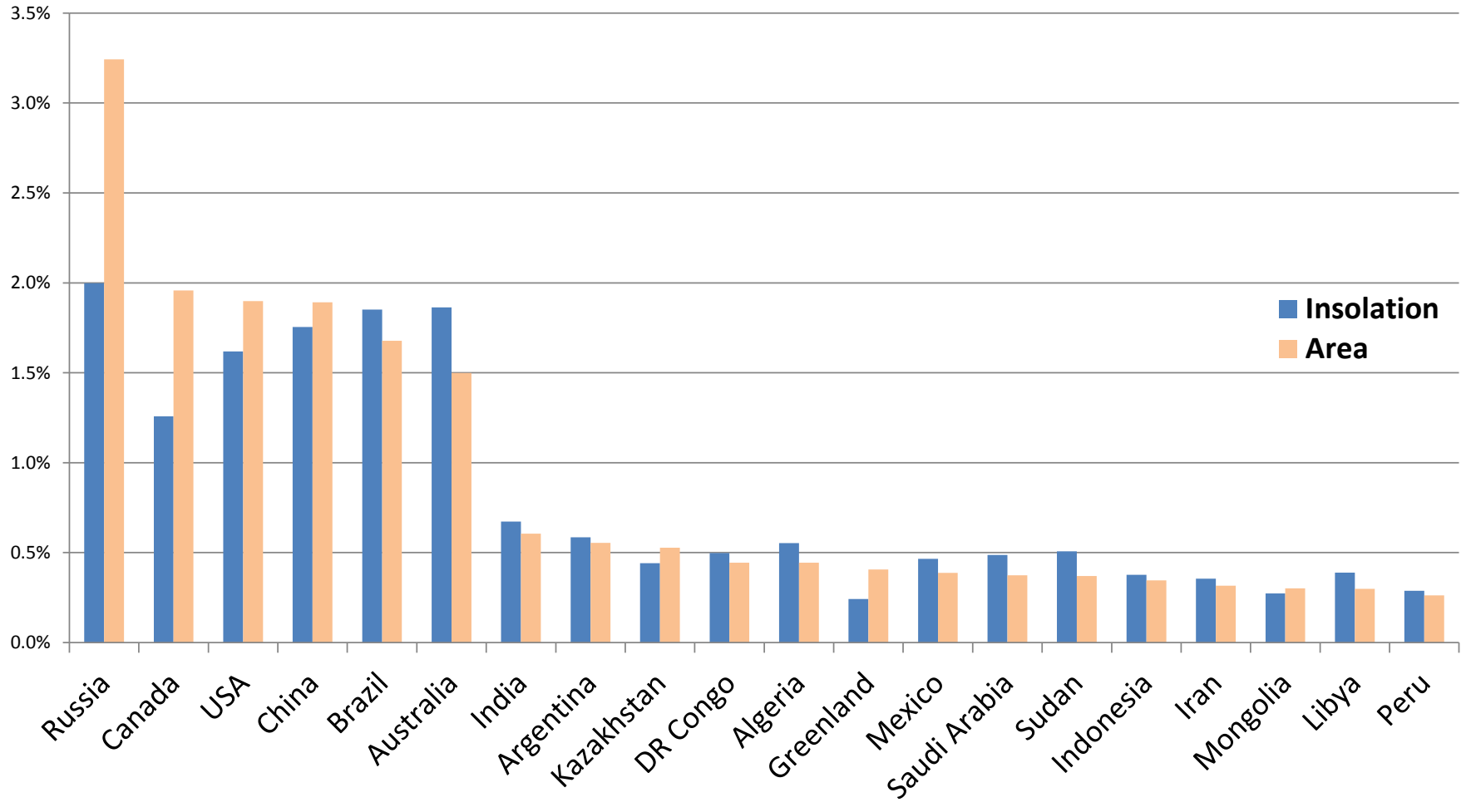


### 3. At Ground level from South side

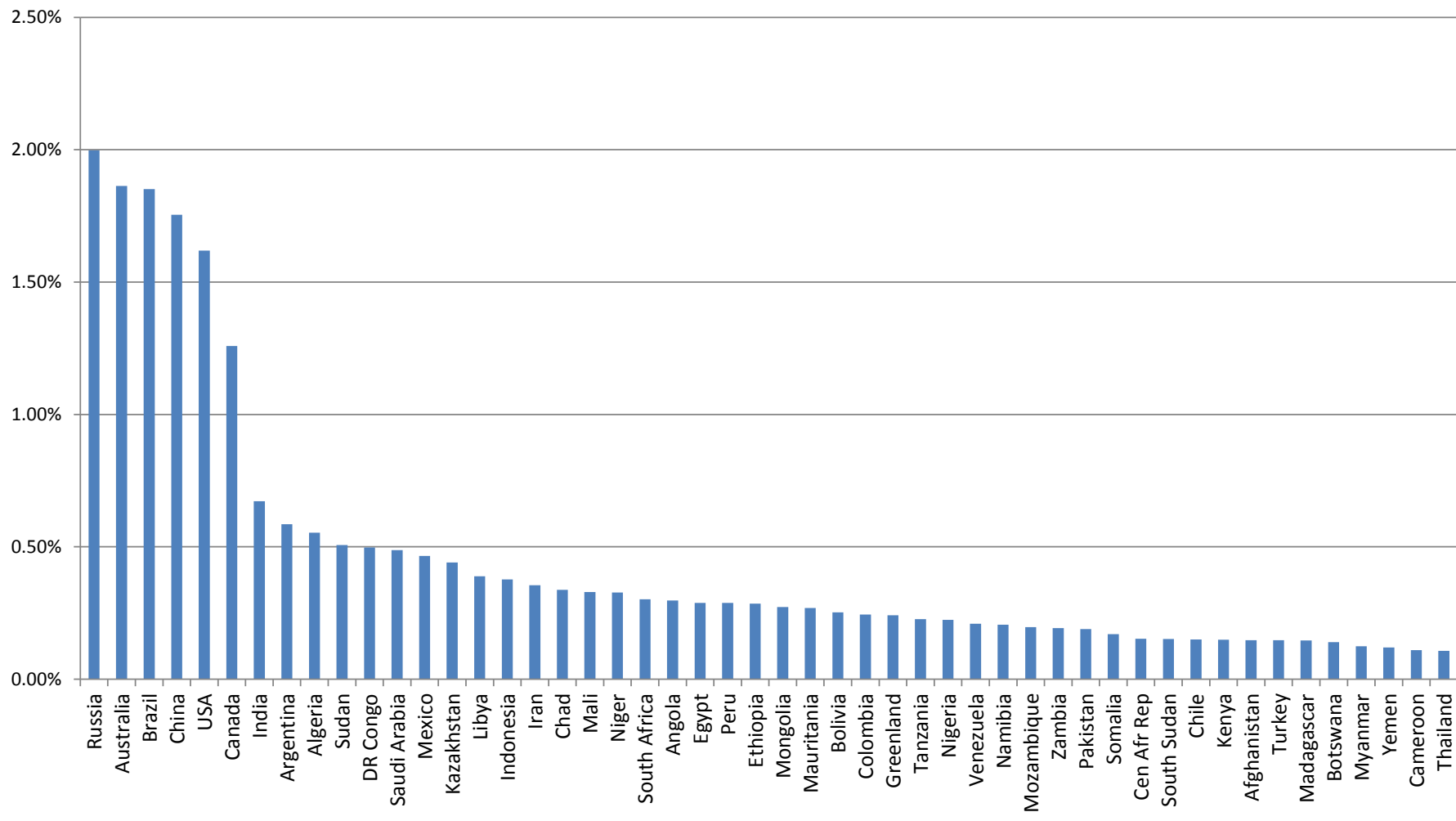




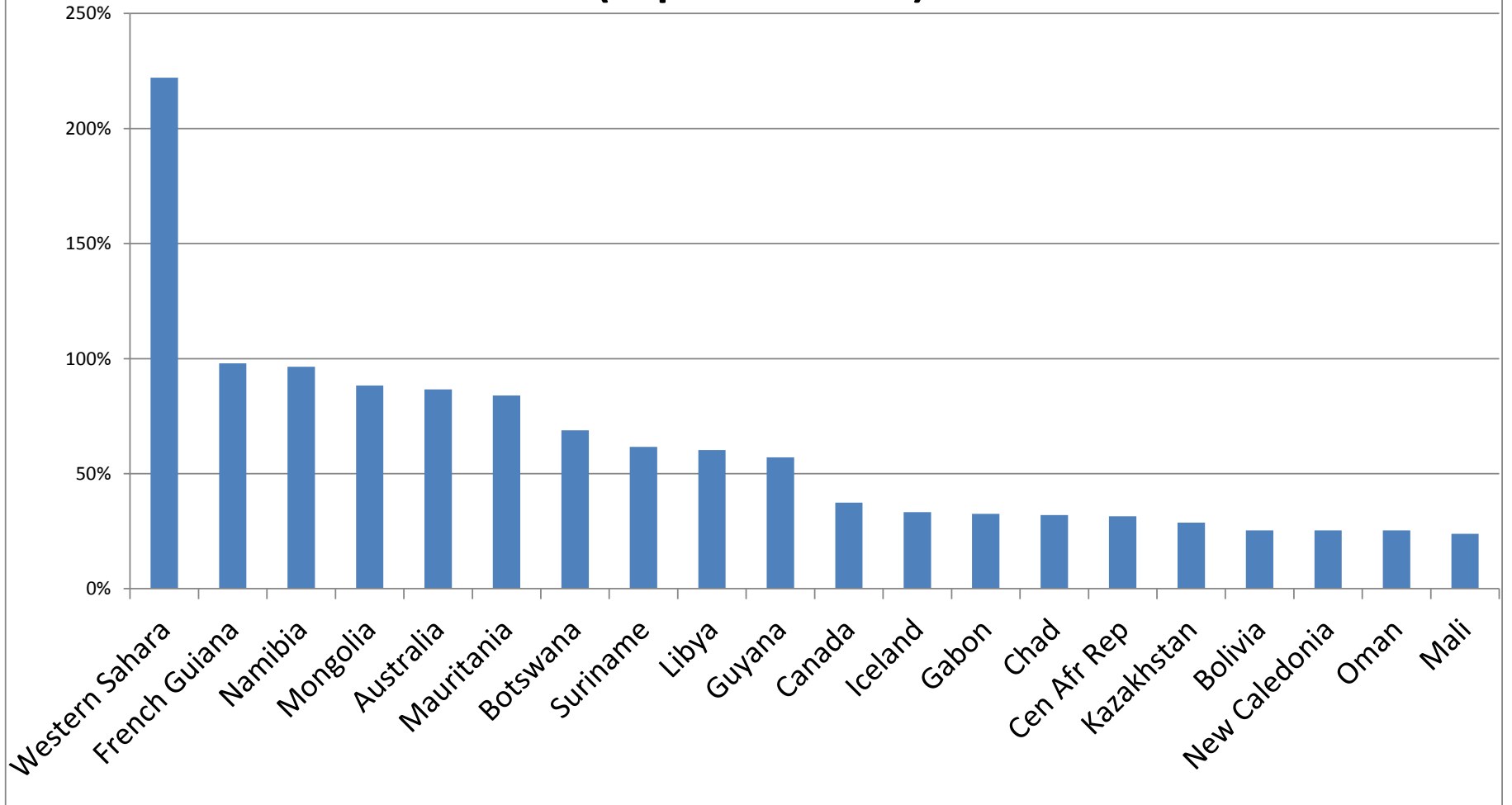
# %age of Earth's Solar Insolation and Land Area per Nation



# %age of Earth Solar Insolation at Ground Level per Nation (Top 50)

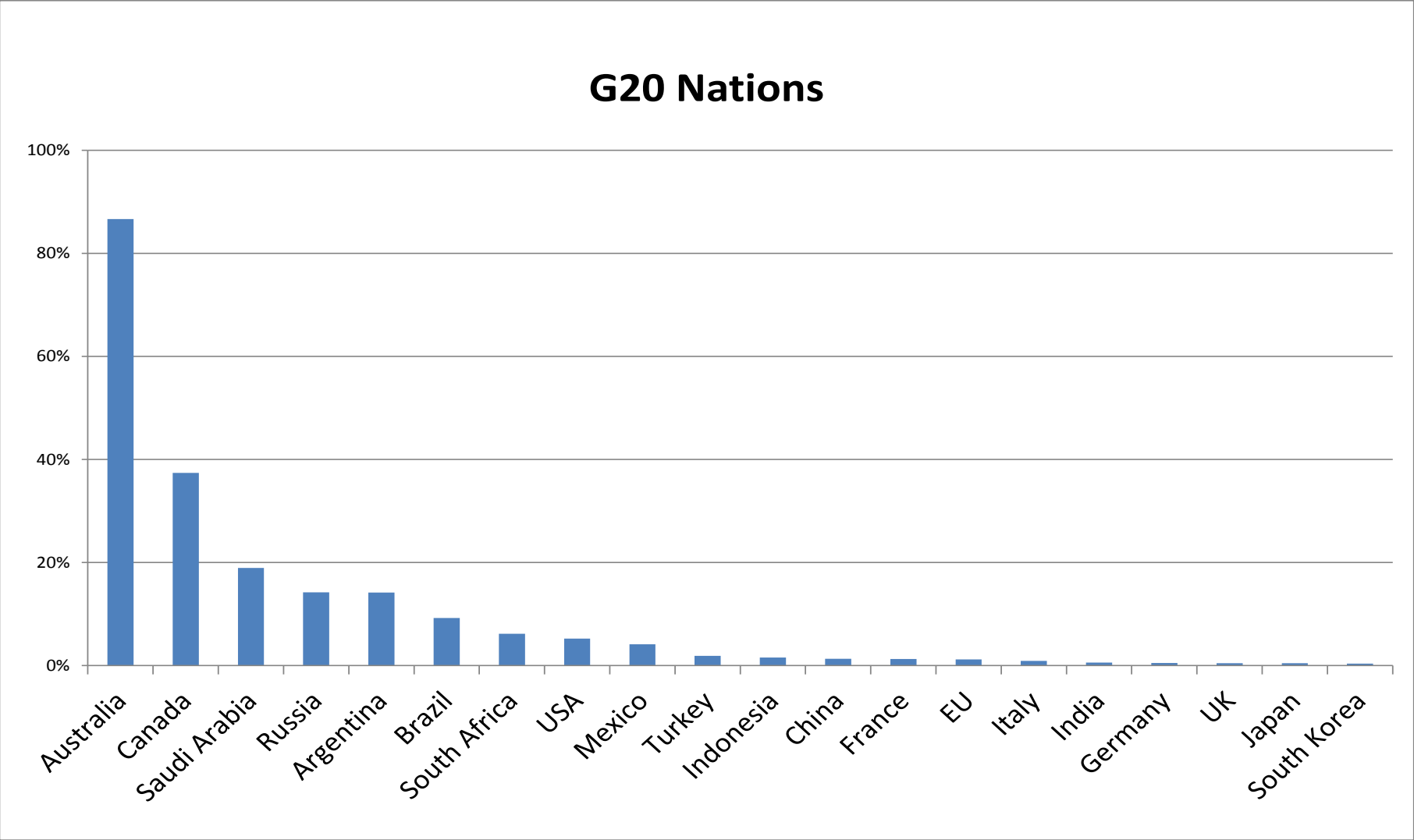


## Relative Per Capita Insolation (Top 20 Nations)



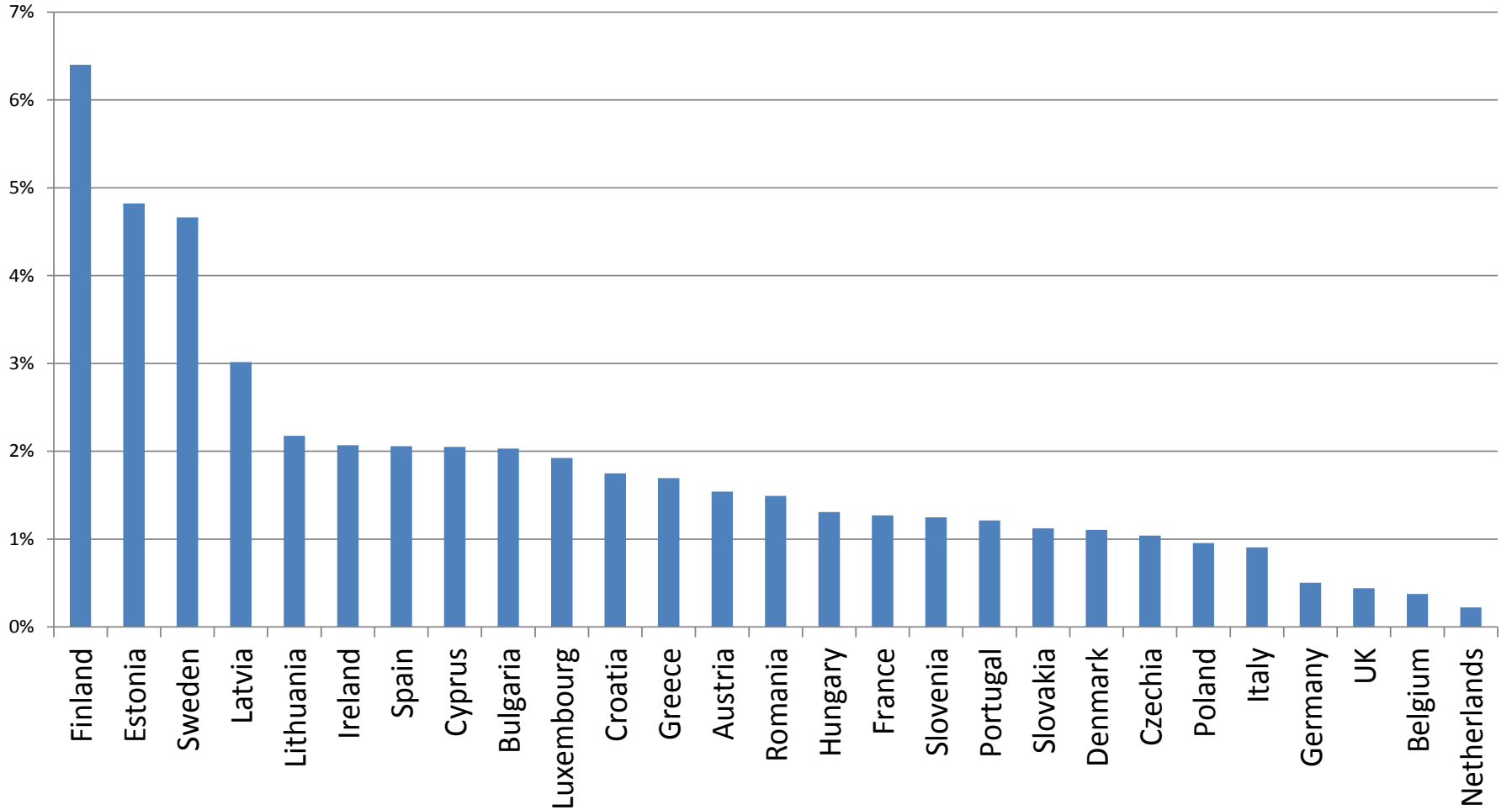
# Per Capita Insolation

## G20 Nations

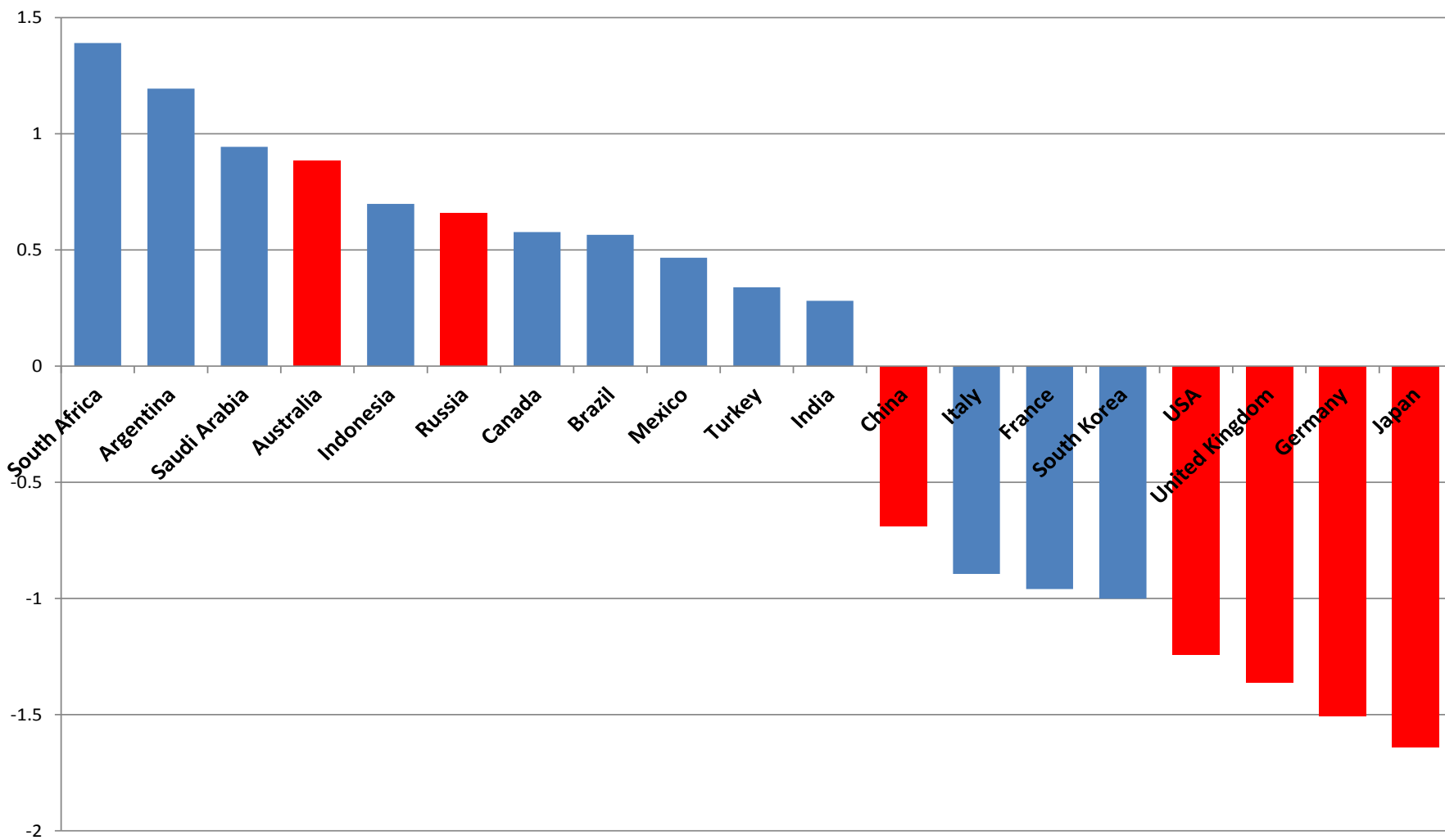


# Per Capita Insolation

## EU Nations

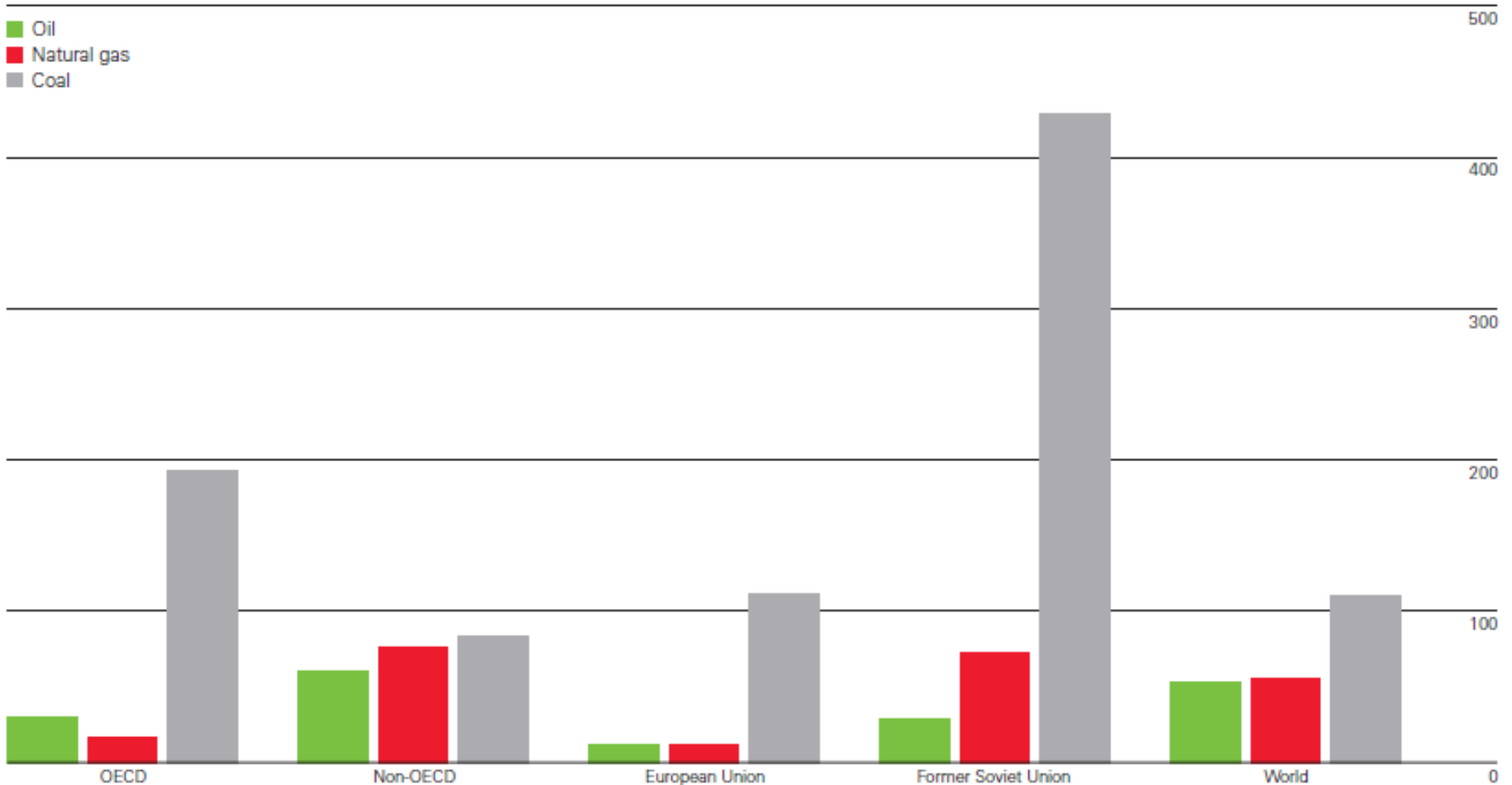


$\log_{10}(\text{Solar}/\text{\$GDP})$  for G20 Nations



## Fossil fuel reserves-to-production (R/P) ratios at end 2014

Years



Coal remains – by far – the most abundant fossil fuel by R/P ratio, though oil and natural gas reserves have increased over time. Non-OECD countries account for the majority of proved reserves for all fossil fuels. The Middle East holds the largest reserves for oil and natural gas, and the highest R/P ratio for natural gas; South & Central America hold the highest R/P ratio for oil. Europe & Eurasia holds the largest coal reserves and the highest R/P ratio.

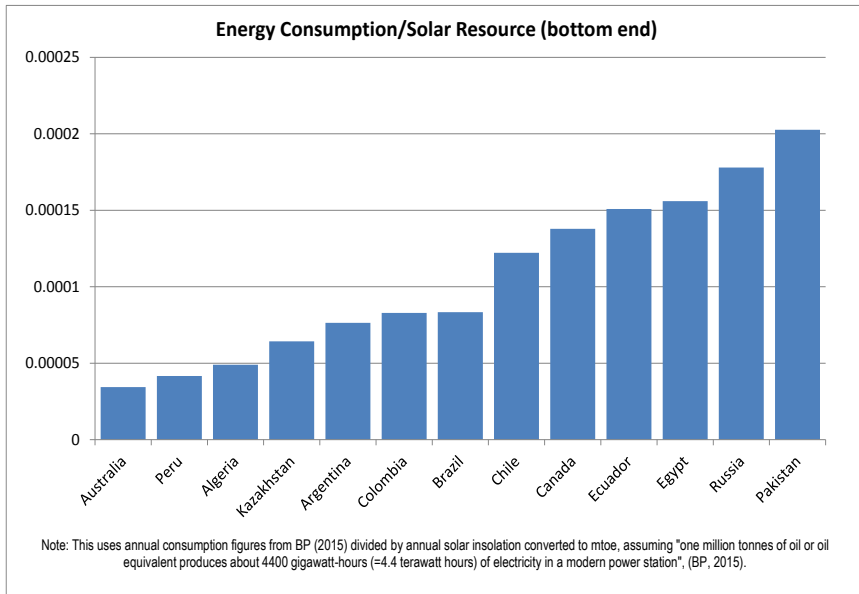
Source: BP Statistical Review of World Energy 2015 Full Report, p. 43

Top and Bottom End of the graph of  
Energy Consumption/  
**Solar Resources pa**

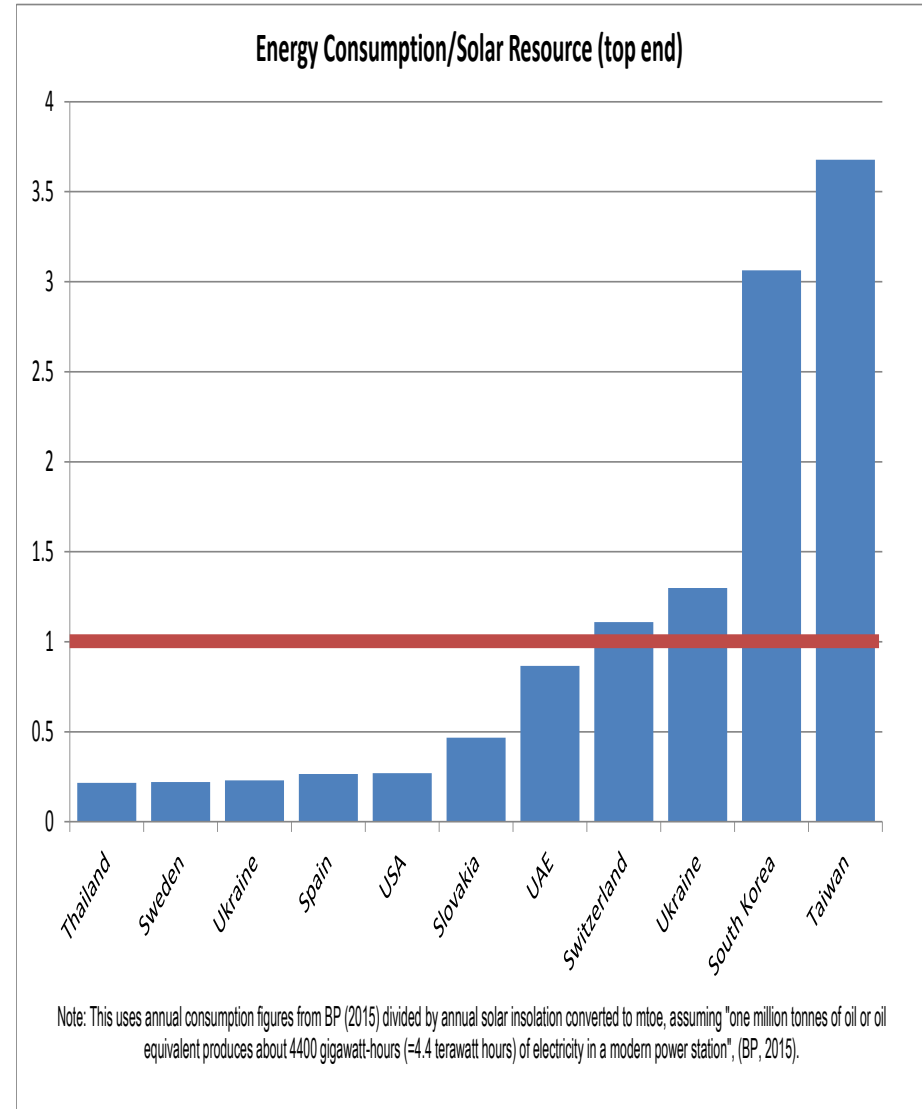
Graph A: Left-hand Scale: **0 to 4**

Graphs B: Left hand Scale  
**0 to 1 in 4000**

↓  
**Graph B**

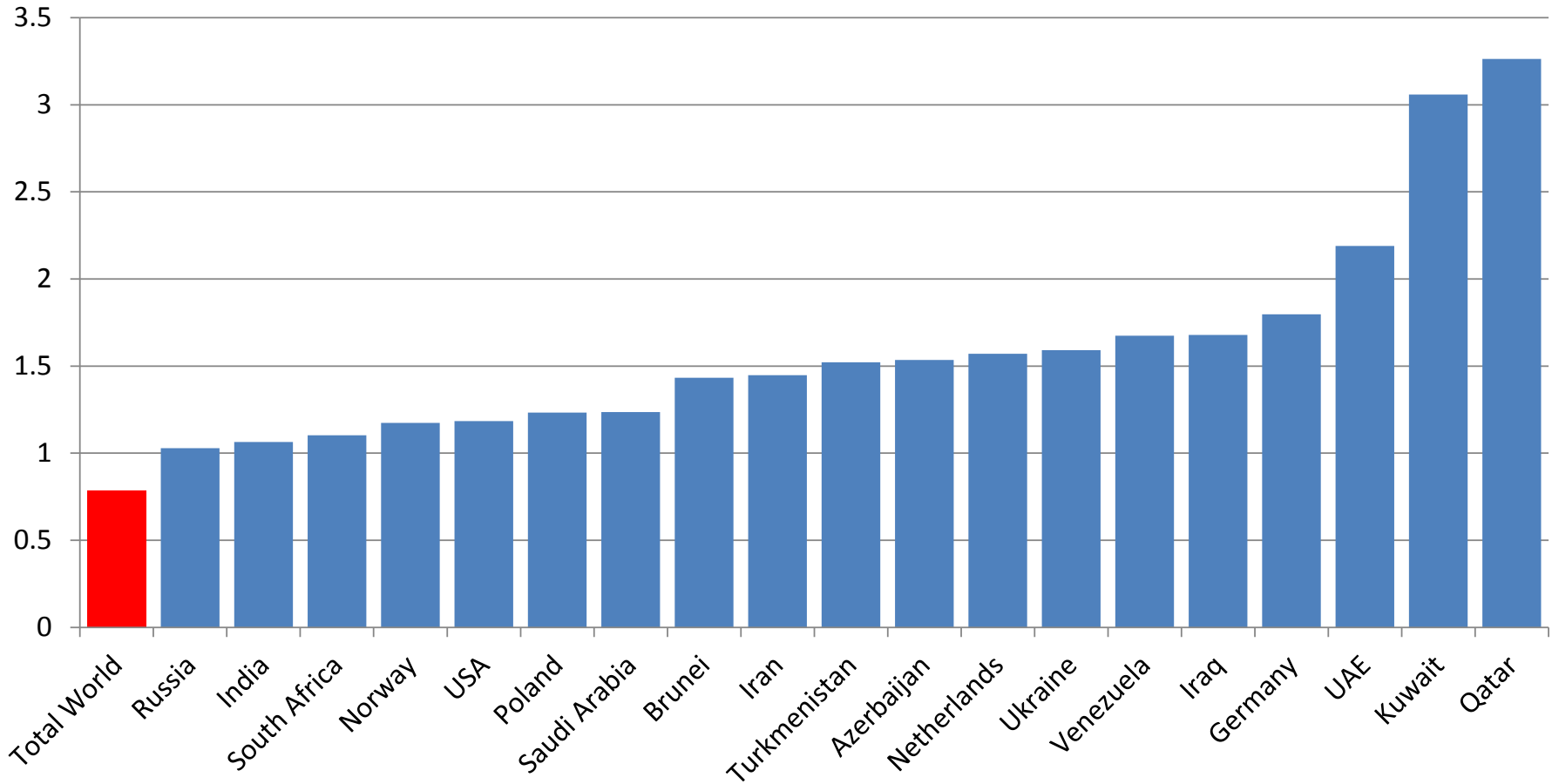


# Graph A





## Log(National Fossil Fuel Reserves in terms of Years of their Solar Insolation)



Note: This uses Oil, Gas and Coal Reserves from BP (2015) converted into mtoe, summed and divided by annual solar insolation converted to mtoe, assuming "one million tonnes of oil or oil equivalent produces about 4400 gigawatt-hours (=4.4 terawatt hours) of electricity in a modern power station", (BP, 2015). Thus it is the fossil fuels reserves of each country divided by that countries solar insolation in one year.