

Peak Oil and the Carolinas: Electrified Freshmen Do the Numbers

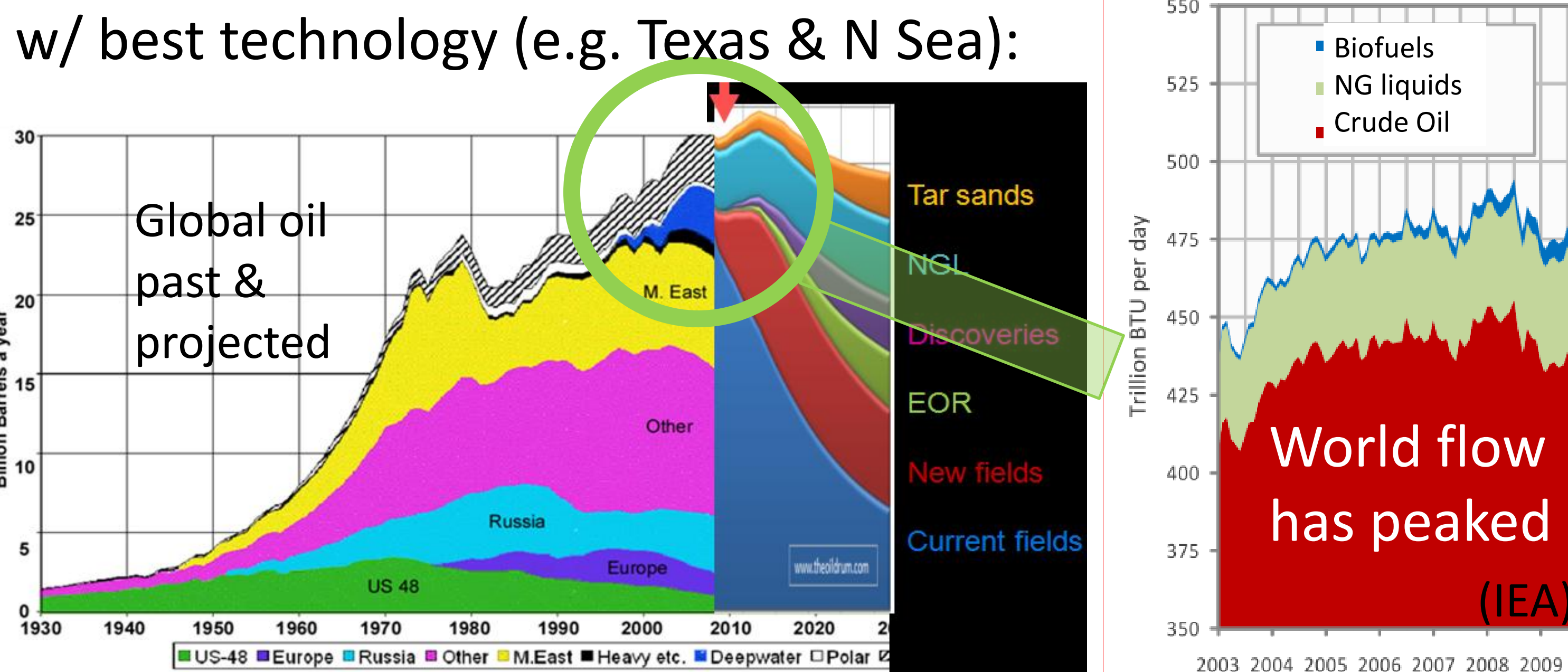
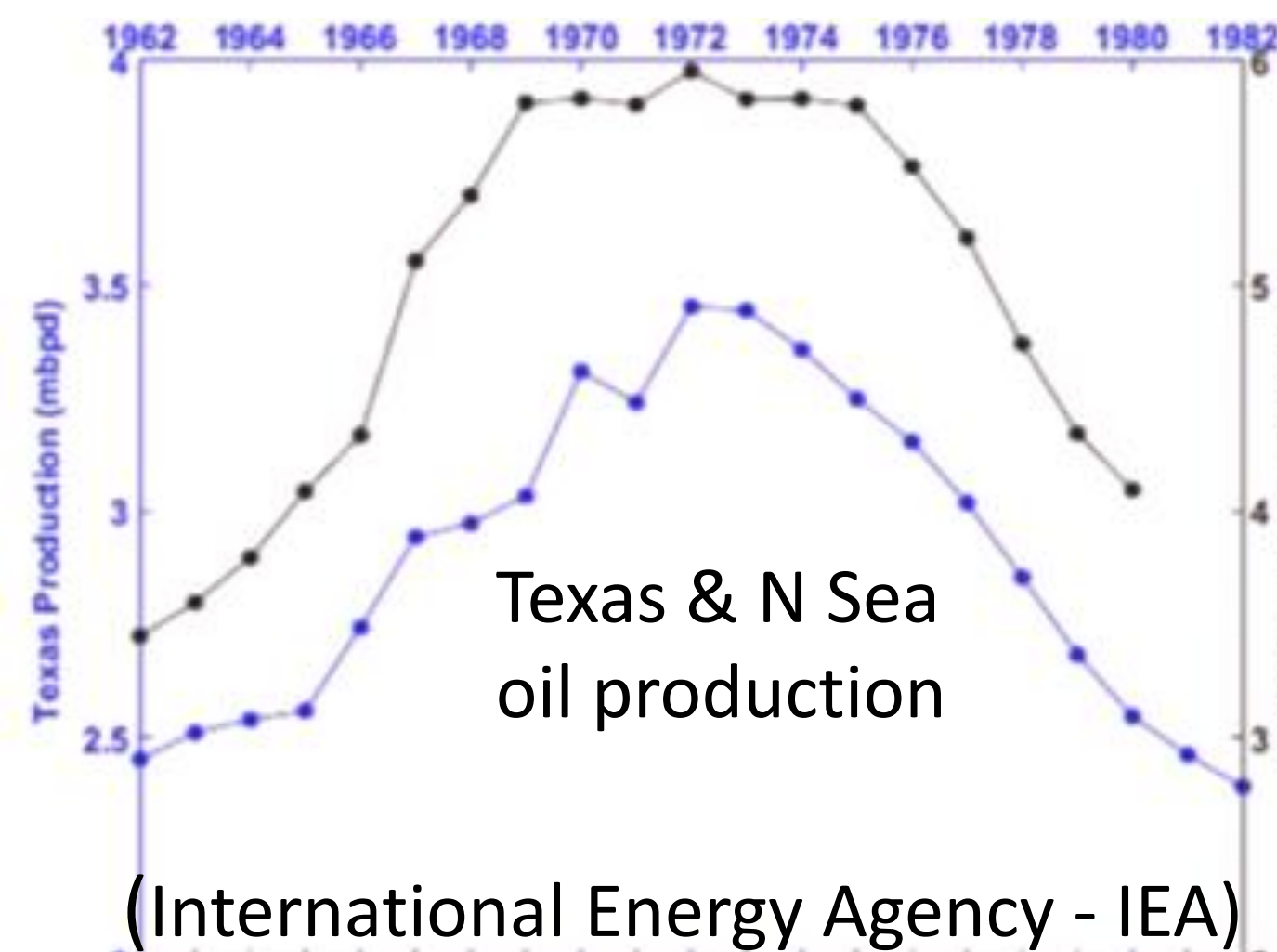
PHYS 071 students + Prof. Gerald Cecil UNC-CH

Abstract

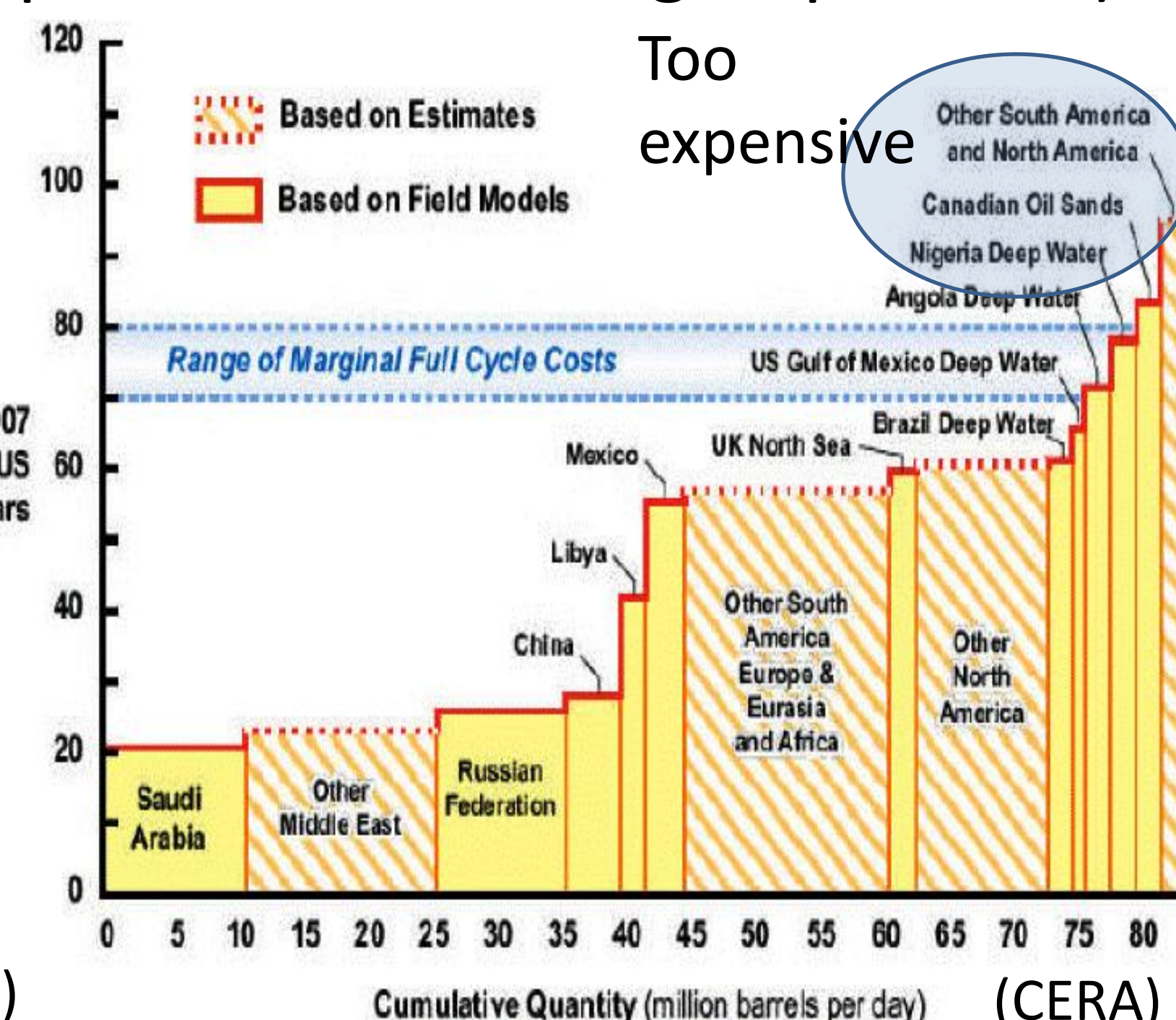
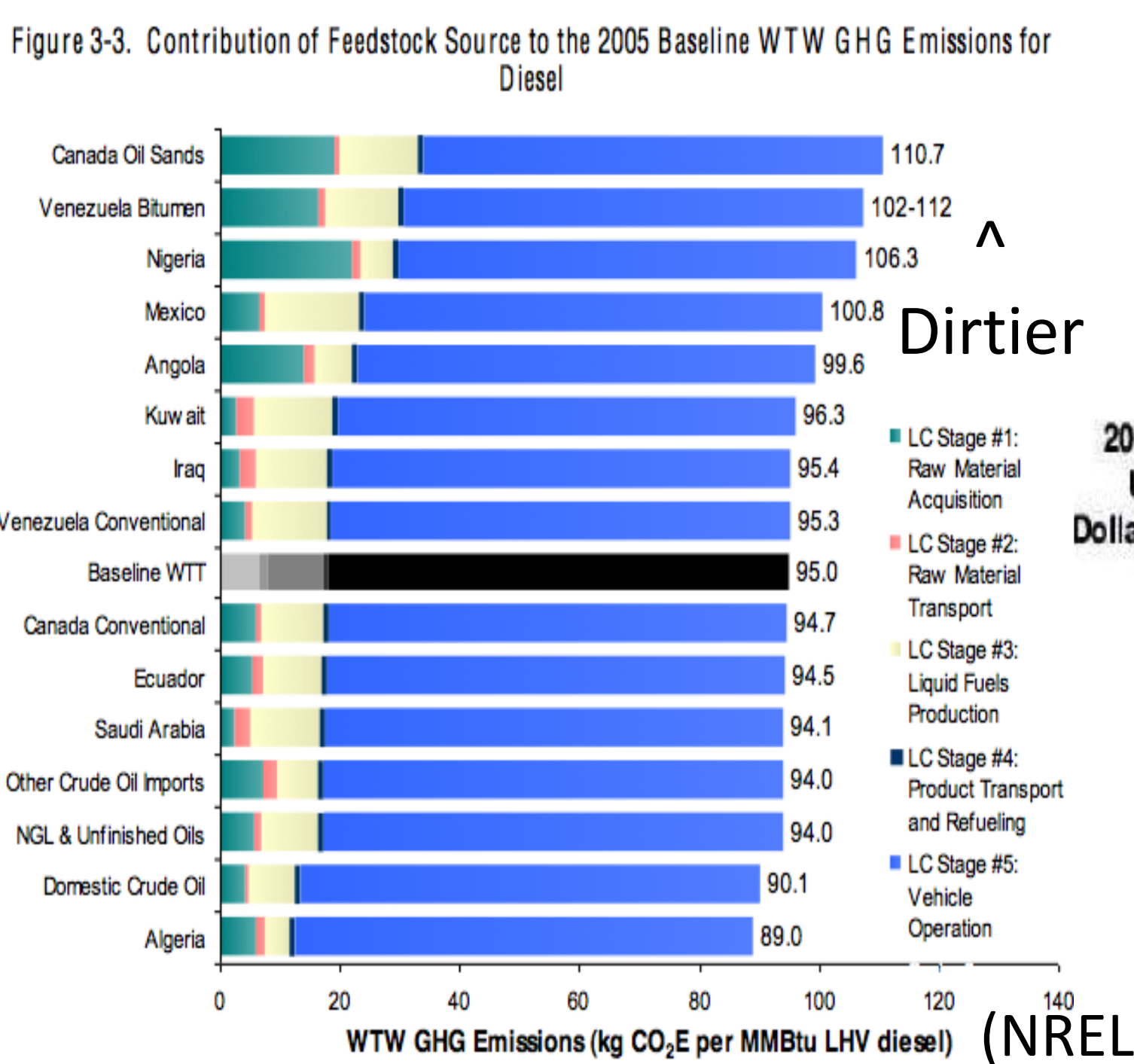
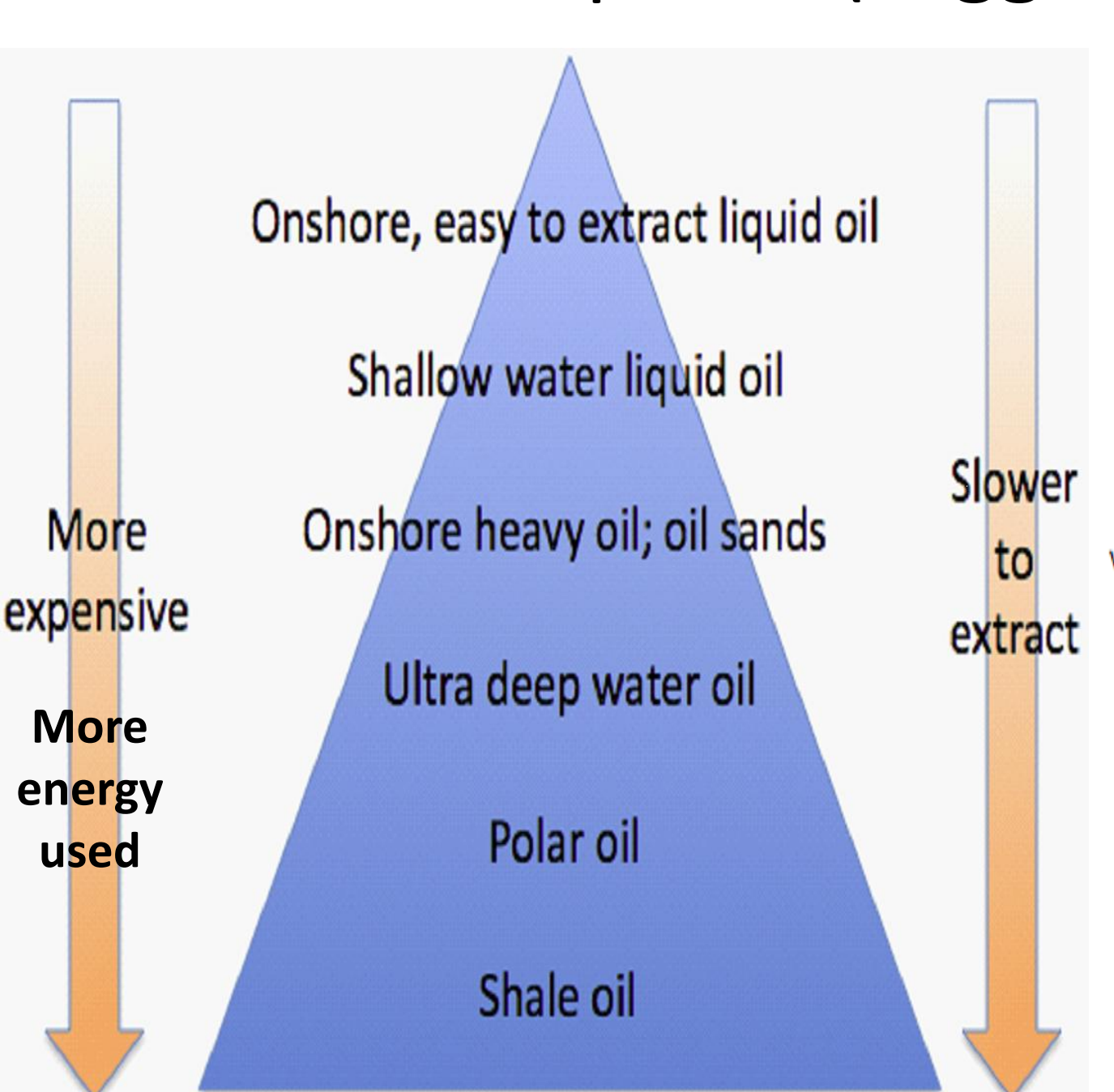
A Fall 09 First-Year Seminar examined ways to mitigate impact of a 40% decline in available petroleum per capita for US transportation that is projected within 15 years because of interacting constraints denoted "Peak Oil" and increased use in developing economies. Peak Oil asserts that the decline of petroleum reservoirs has not been overcome by technically challenging, smaller flows from deep water and tar sands. Although the most obvious compensating tactic is car-pooling and greater reliance on rail transport of goods, the mitigation strategy that attempts to maintain **business-as-usual** (BAU) would likely be transport electrification. The 8 GW*yr energy increase required is a daunting target for solar power even augmented by wind off-shore NC. Our solution is to construct 9 new large nuclear plants in N+S Carolina during this transitional interval of petroleum decline, implying 150 new large reactors nationwide (~250 total).

Context: Peak oil = expensive new fields fail to augment depleting reservoirs

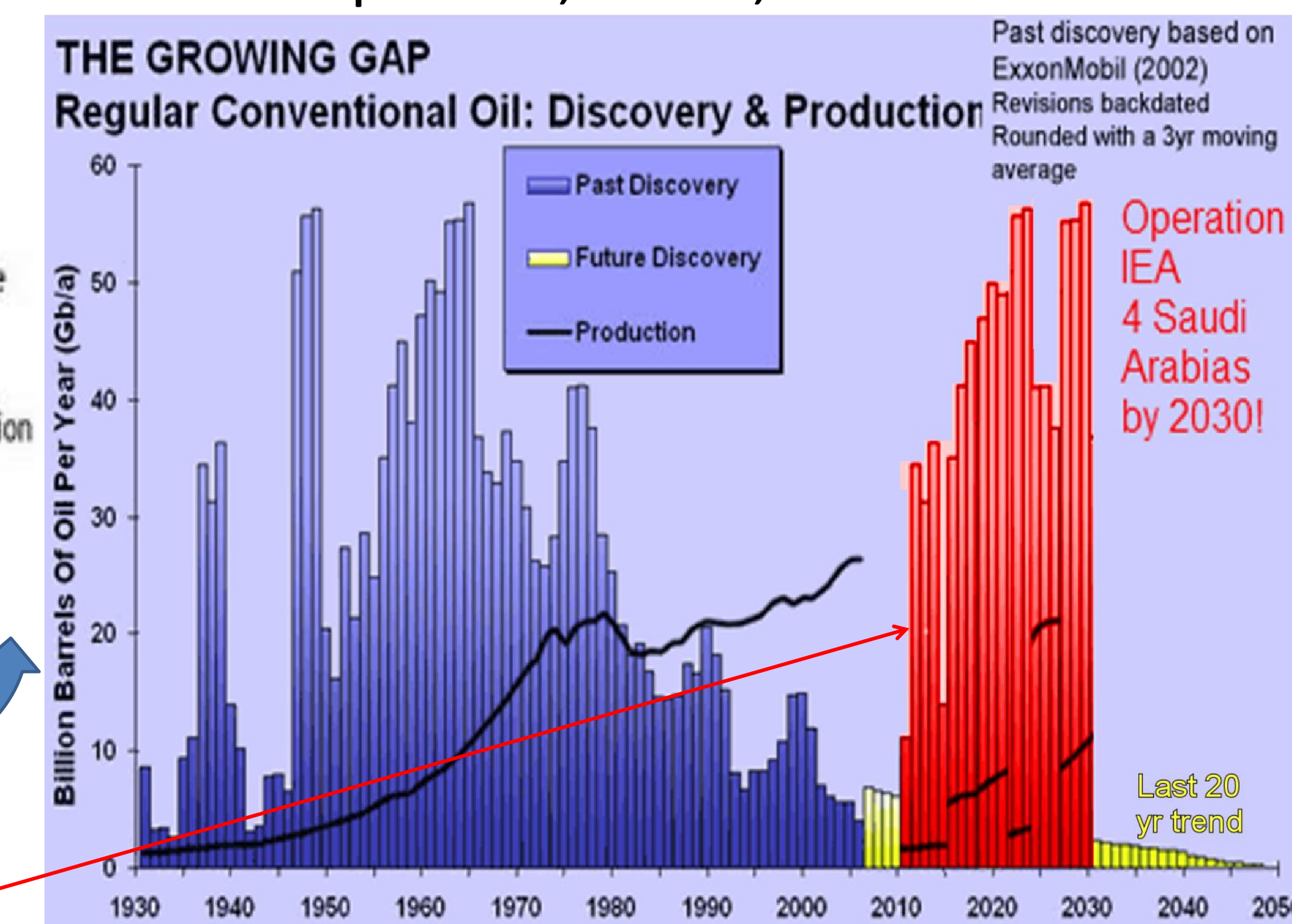
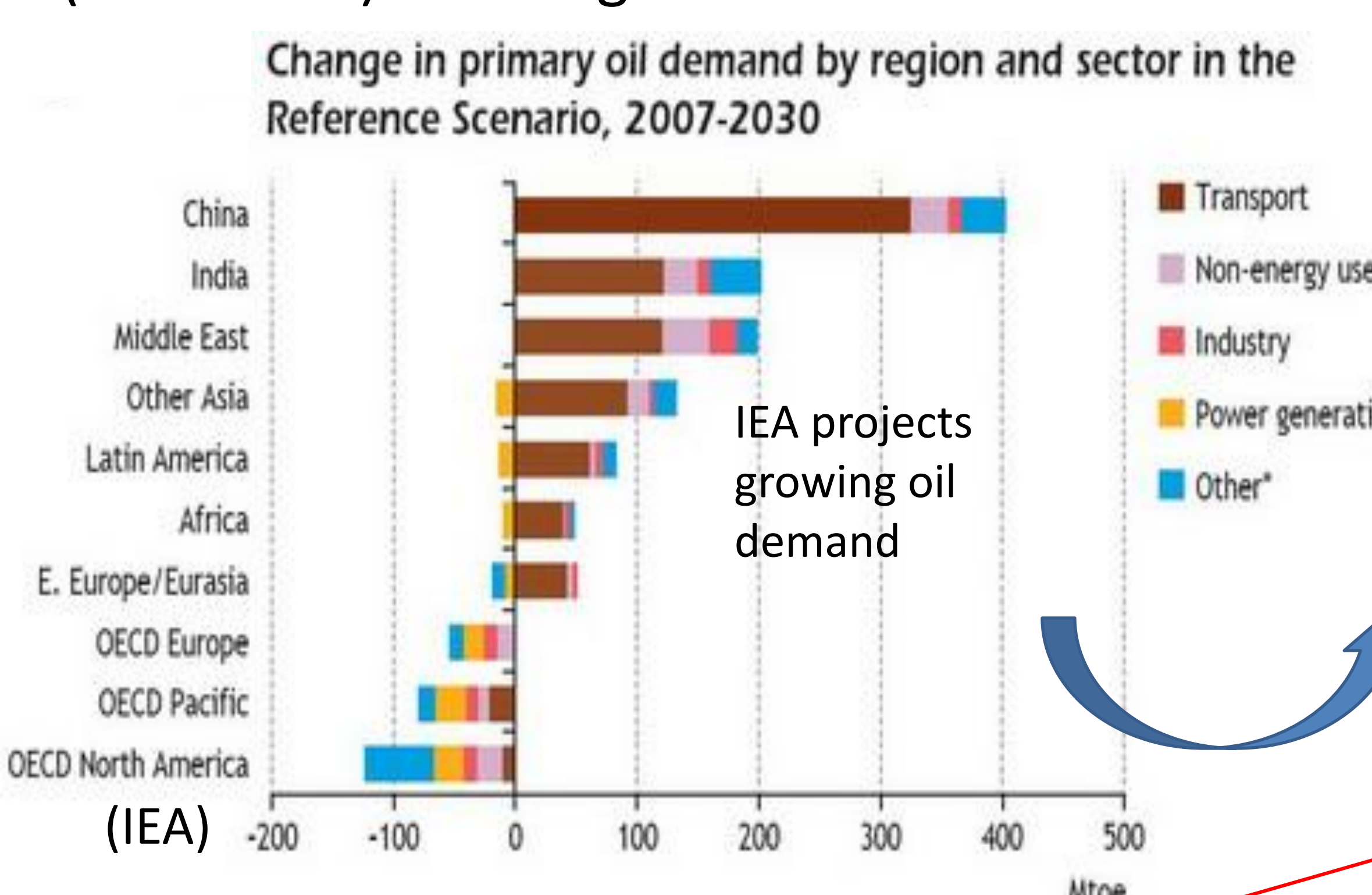
• Reservoirs depressurize even w/ best technology (e.g. Texas & N Sea):



• Abundant but low-value/slow flow supplements have larger energy input/CO₂ output & unsustainable prices (triggered recession that "bankers" deepened into looming Depression):

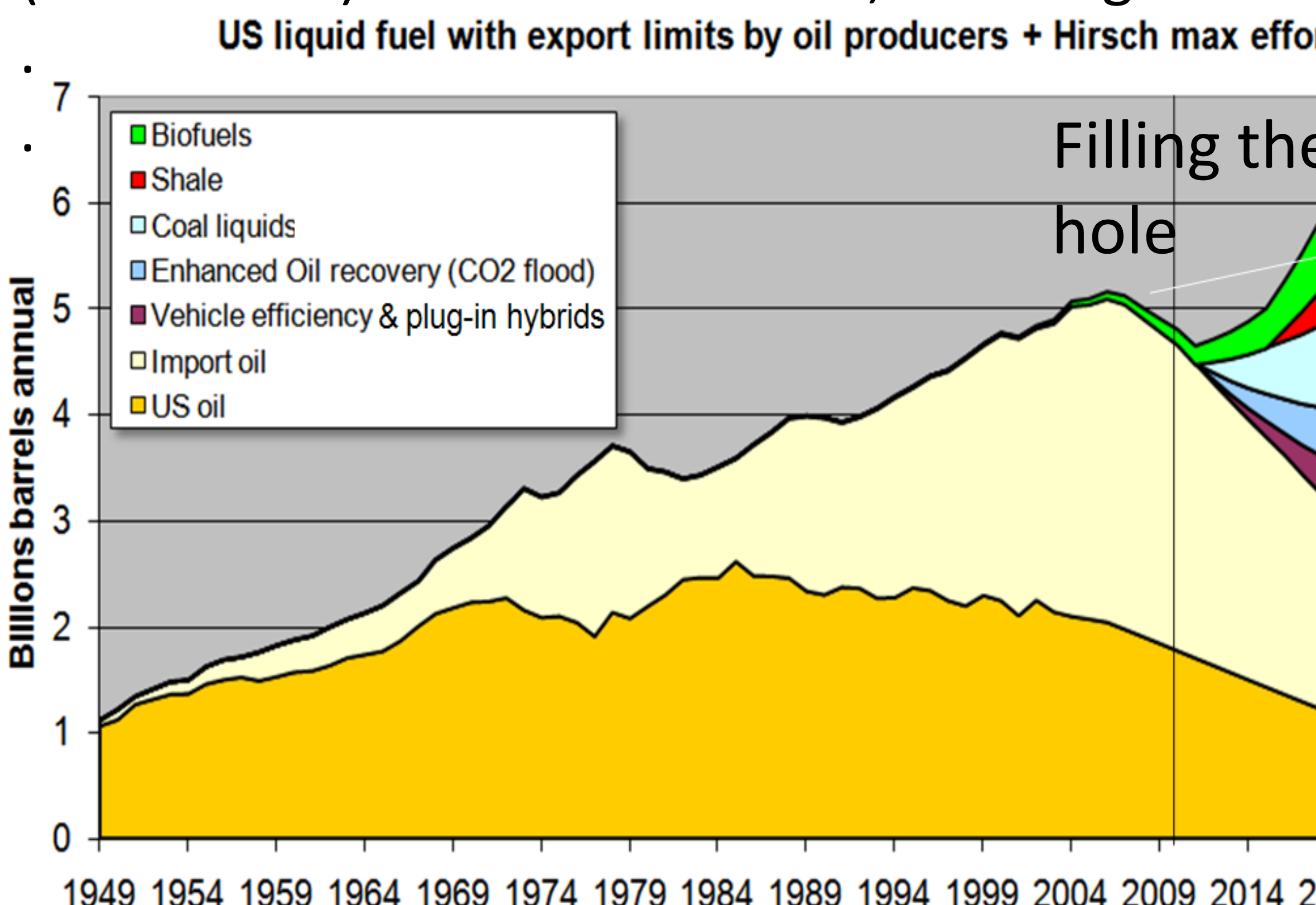


• (left below) Growing domestic demand in Middle East oil exporters, China, & India:



• BAU: just discover 4 new Saudi Arabia's after 20 yr of few discoveries (yellow projected ^) !!
RESULT: optimistic assessment without exporter limits is plotted at middle top of this column.
 → US oil consumption / cap by 2025 becomes 80% of today. Exporters could cut us to 60%.

Mitigating this oil shock takes >10 yr of WW II level effort (Hirsch et al) starting ASAP to build (i.e. no R&D) more efficient cars, coal- & gas-to-liquid, shale, CO₂ sequestering enhanced oil production, supplemented by 2nd gen biofuels (green).



BUT carbon intensive! If sunspots increase then global warming continues & CO₂ & methane emissions must be limited.
 So, **PHYS 071 freshmen worked #s to fully electrify transport** (e.g. plug-in hybrids & electric vehicles) **in Carolinas, retaining BAU travel patterns.**

Projected N+S Carolina petroleum use 15 yrs hence

- 70% of oil consumed is for transport vs. 50% nationally
- 1.8% annual population growth assumed
- BAU miles driven assumed (suburbia persists)
- 40% decline in petroleum / capita over 15 yrs

Results of PHYS-071 seminar analysis:

BAU Carolinas transport possible by Electrification?

- Agnostic to power source, no impact on food production
- Need grid upgrades to handle neighborhood power load
- Replace ICE w/ Chevy Volts. Volt uses 25 kWh / 100 miles vs. Civic hybrid 90 kWh / 100 mi → Need 11 extra GW*yr to energize Volt batteries
- 3 GW*yr energy from
 - wind (four 600 MW x 25% capacity = 6% of needed energy)
 - Off-peak charging from existing power plants
- Still require 8 GW*yr more energy annually for transport
- Would need 3 million 10-kW PV arrays charging for 8 hrs/day, covering 33 x 10 km² for N+S Carolina OR

Seminar settled on Nuclear Power for Carolinas
 Need 9 new 1 GWe plants totaling ~\$63 billion = \$4600/cap

Scaling from Carolinas to all US (w/ www.powerdown.us)

- 150 new nuclear powerplants over next 15 yrs of BAU
- # new nukes/150 built by then = fraction of BAU travel maintained by 2025.

