Energy and Sustainability in Europe

Introduction

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Background

- Content based on “Next Energy”
  - Originally developed by Dr. John Weidner, ChE

- An introduction to the technical challenges of sustainable energy production and consumption

- Survey a variety of topics

Biomass
Hydro
Solar
Wind
Construction
Nuclear
Distribution
Transportation
Storage
Agriculture

Society's Top 10 Problems by Richard Smalley*

1. **ENERGY**
2. Water
3. Food
4. Environment
5. Poverty
6. Terrorism and War
7. Disease
8. Education
9. Democracy
10. Population

* Nobel prize in Chemistry for Buckminsterfullerene

Motivation: Why do we need to do something different?

- Limited Resources
- Energy Independence
- Environmental Impact
- Regional Issues
- Regions where energy is obtained.
  - Arctic National Wildlife Refuge
- Economics

Energy Needs

- 15 terrawatts (TW) of power used today
  - 2008 estimate
- 3 TW in U.S. alone.
- 28 TW by 2050 projected

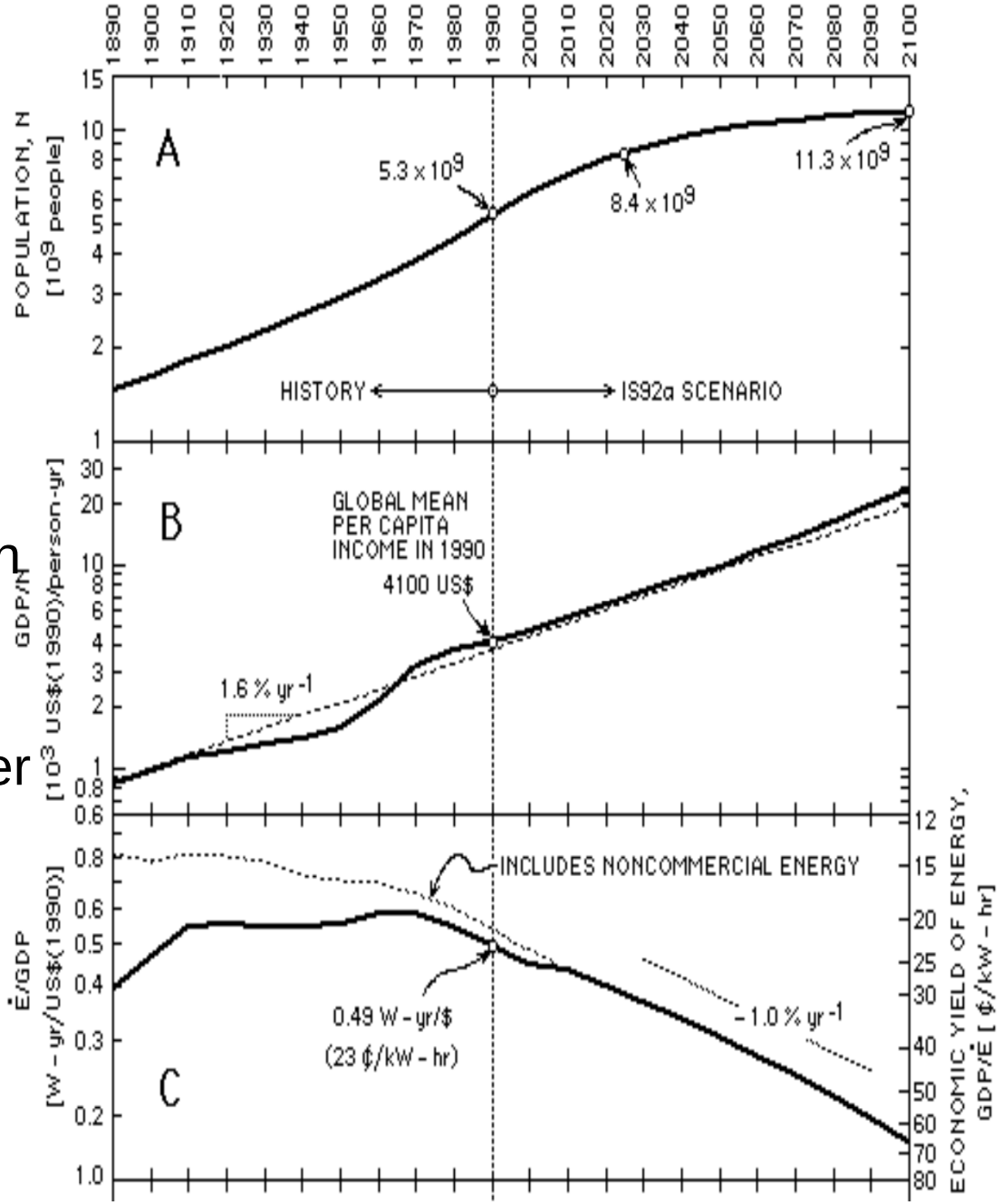
- One nuclear reactor = 1 Gigawatt (0.001 TW)
- One coal plant = 500 Megawatts (0.6 GW)
  - Range from 100 MW to 2 GW

Population Growth to 10 - 11 Billion People in 2050

Per Capita GDP Growth at 1.6% yr^{-1}

Energy consumption per Unit of GDP declines at 1.0% yr^{-1}

Nate Lewis, Cal Tech



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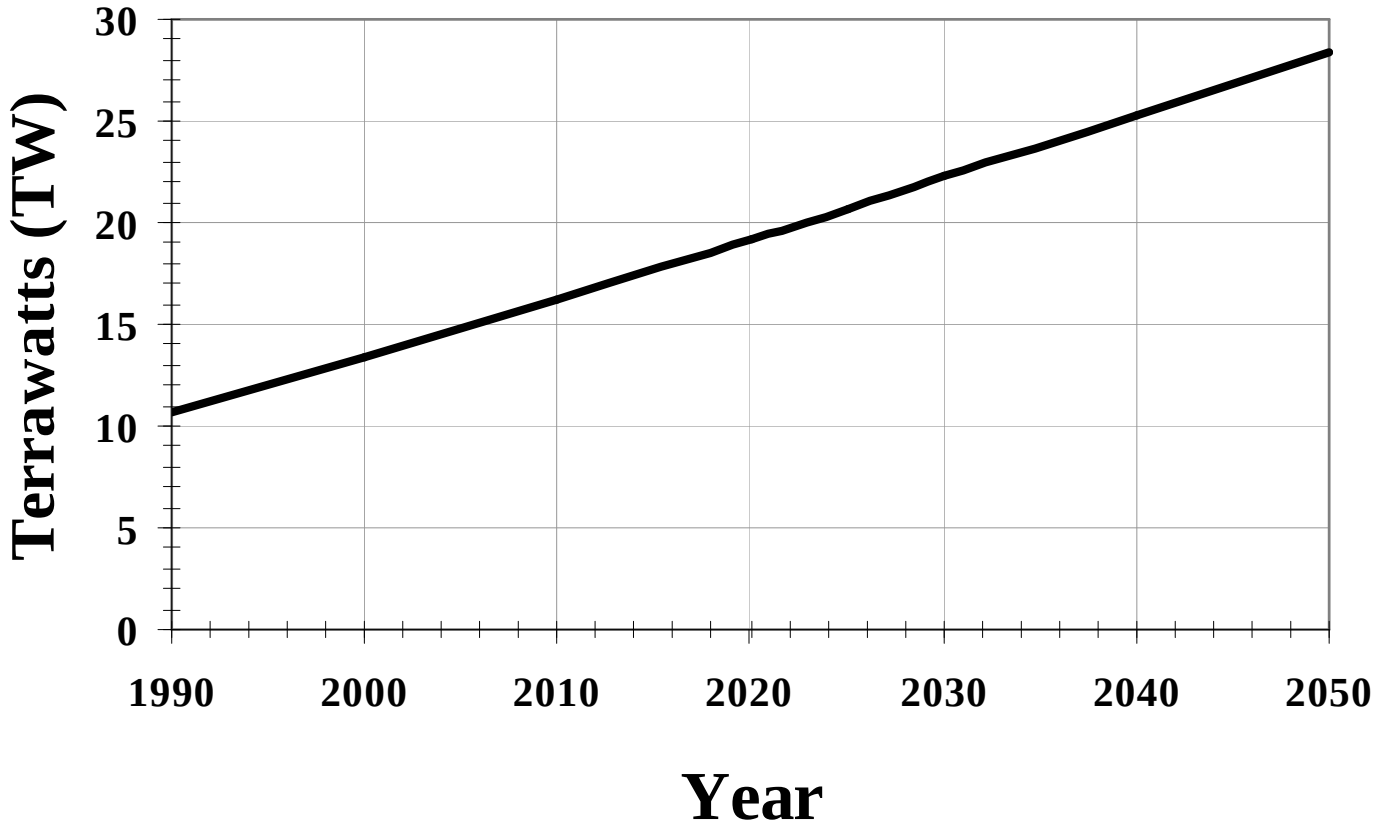
Global Energy Needs



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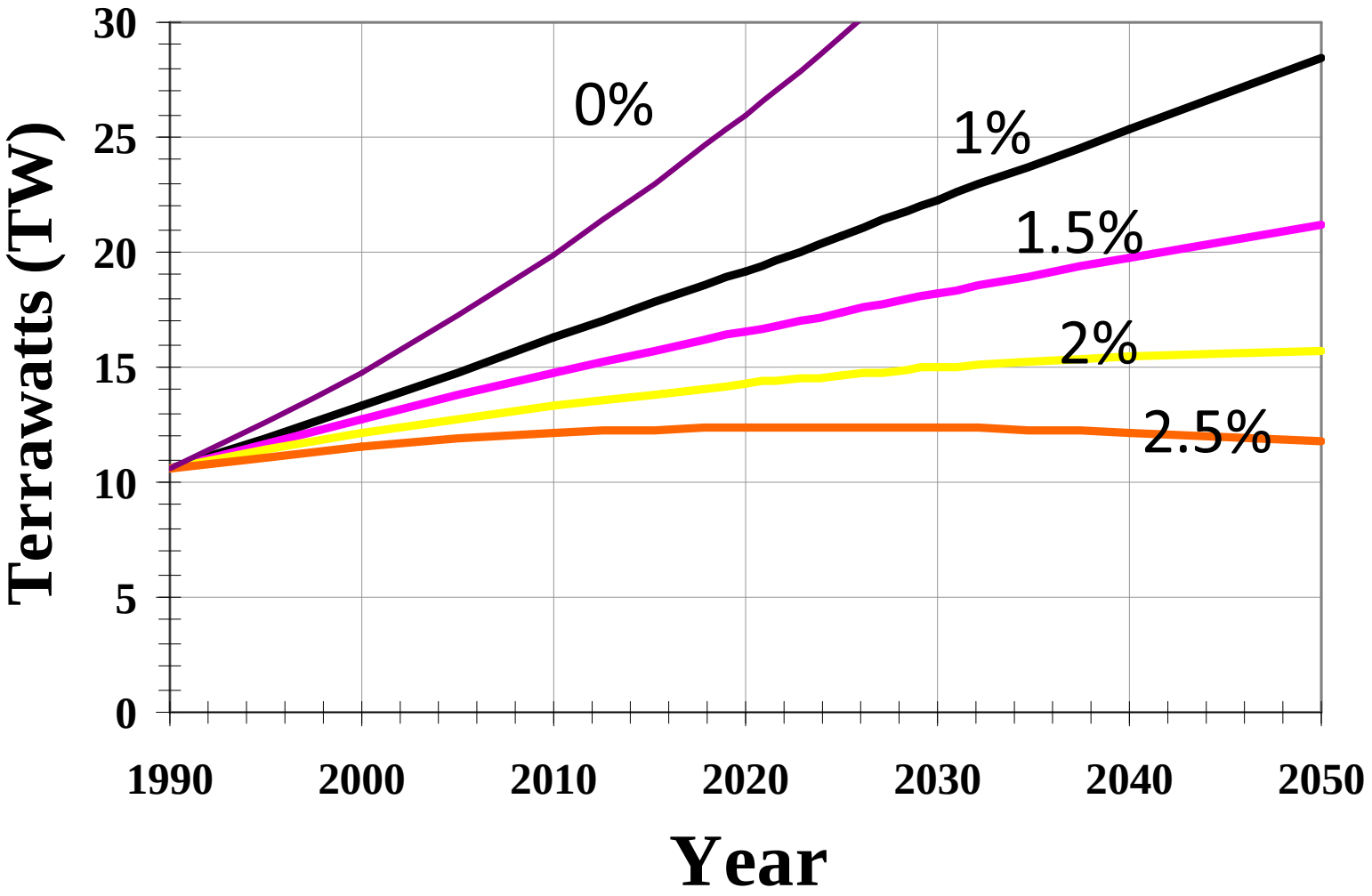
Effect of Efficiency



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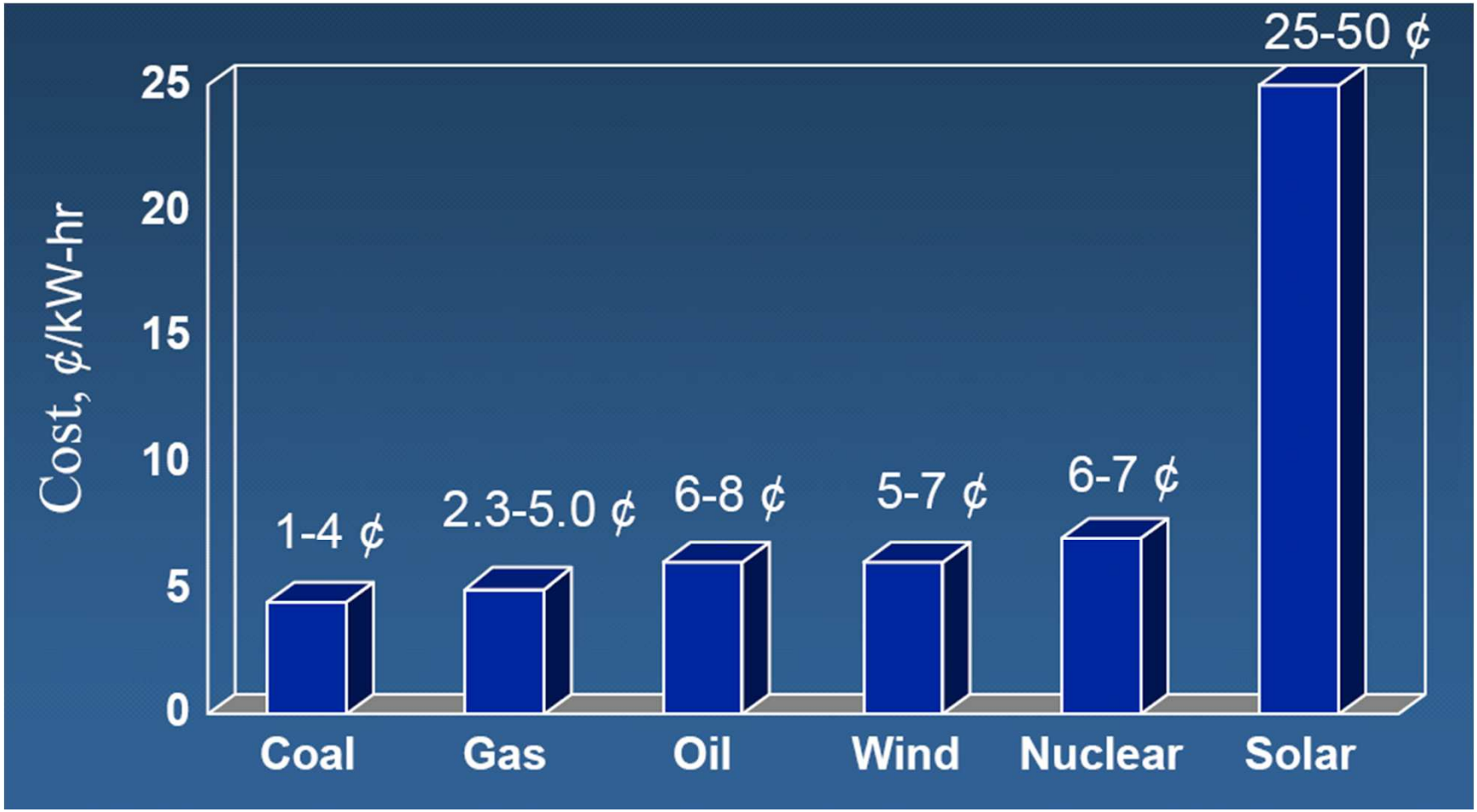
Energy Options

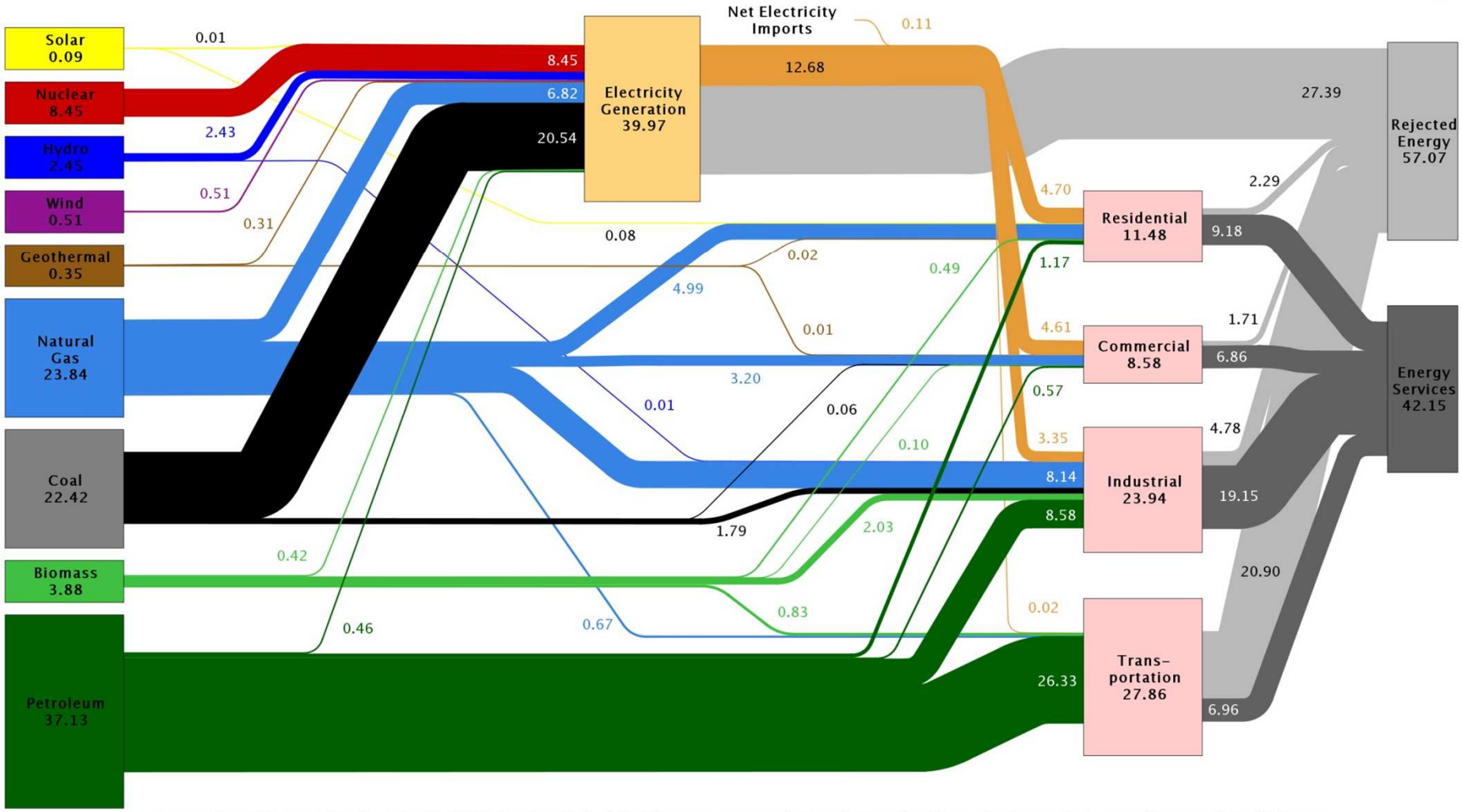
- Biofuels (e.g., biodiesel, ethanol)
- Nuclear
- Solar
- Wind
- Hydroelectric
- Waves and Tides
- Geothermal
- Conservation

Approximate Energy Costs (2002)



Estimated U.S. Energy Use in 2008: ~99.2 Quads

Lawrence Livermore National Laboratory



Source: LLNL 2009. Data is based on DOE/EIA-0384(2008), June 2009. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

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Energy and Sustainability in Europe

Schedule

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April

- Three meetings on Thursday nights
  - Required attendance

- First meeting – Intro and basics
  - Topic selection, logistics and details
- Second meeting
  - Energy production methods overview
- Third Meeting
  - Efficiency and energy related technologies

Pre-travel Assignment

- 1-2 slides on your selected topic
  - Basic concept
  - Advantages
  - Disadvantages
  - Image / schematic

- Email to gatzke@sc.edu by Wednesday at 5:00 PM

Saturday (May 5)

- Flying from Charlotte at 4:45 PM
- Arrive at 2:30
  - Assemble at 2:45 US Airways Ticket Counter
- Getting to Charlotte
  - Parking at CLT is cheap
  - CLT is close
  - Shuttle available ($50)
  - Groups for carpool?

- Why? Direct flight, cheaper

Sunday (May 6) - Freiburg

- Train from Frankfurt to Freiburg (ICE)
- Staying near the main train station
- Afternoon is free
  - Hike up to observation tower?
  - Wander around old town
- Freiburg is Medieval town

Monday (May 7) - Freiburg

- Afternoon bus tour to nearby rural area (Black Forest)
  - Wind / solar / agricultural, dinner at restaurant in barn

1.	**Meeting point: Konzerthaus Freiburg**	13:00	
2.	**A Black Forest Community that Exports Electricity** This community of about 4,300 inhabitants produces 140% of their electricity needs from renewable energies. ▪ **Visit to a farm** with a wood chipping plant for recovering heat and see a water heating method run by recovering heat from fresh cow's milk. ▪ **Wind power** Visit one of 142 wind turbines financed by shareholders. Each turbine produces electricity for 1000 households. ▪ **Sustainable energy production in a farm** Visit of a 80 ha farm with a biogas plant that produces over one million kilowatt hours of electricity annually and delivers heat for 14 apartments and the local elementary school. The	13:00 – 17:00	 

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Tuesday (May 8) - Freiburg





- Full day tour of Freiburg
  - Energy efficient buildings
  - Transportation system (bike tour possible, lunch)
- Freiburg is a “green” city
  - Many environmental initiatives
  - 20-25% green party




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Wednesday (May 9) - Freiburg

- Fraunhofer Institute for Solar Energy (ISE)
  - Research collaborators
  - Not just solar: Fuel Cells, Reformers, Gasification

Thursday (May 10) - Stuttgart

- Travel to Stuttgart by train
  - TGV! through Karlsruhe
- Afternoon is open
  - Wilhelma zoo
  - Biergarten in central park
  - History and art musems
  - Spring festival (Frühlingsfest or Stuttgarter Wasen)

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Friday (May 11) - Stuttgart

- Mercedes Benz Museum
- Porsche Museum

Saturday (May 12) – Ulm / Munich

- Train travel to Ulm
  - Store bags in train station
- Ulm Minster (church) tallest in world
- Afternoon guided tour of Munich
  - at 4:15

Sunday (May 13) – Munich

- BMW Museum
- Deutsches Museum (Technical Museum)

Monday (May 14) – Munich

- Guided tour of BMW plant
- Afternoon open

Tuesday (May 15) – Munich

- TUM (Technische Universität München)
  - Fuels Lab Tour

TECHNISCHE UNIVERSITÄT MÜNCHEN

Wednesday (May 16) – Munich

- Max Planck IPP (Institut für Plasmaphysik)
  - Tokamak fusion reactor
  - Afternoon open
  - Dinner at Hofbrauhaus

Suggestions

- Pack light, you have to move your bags around
- May be chilly so bring some jeans and light jacket
- Consider cleaning clothes in sink
  - Underwear every day?
- Jet lag – Bright light at 8 AM target time
  - Germany is 6 hours ahead
- Consider NOT bringing a laptop
  - WiFi not ubiquitous, but our hotels may have it for free
- Power conversion
  - Most will work with plug only, some not (hair dryer)

Suggestions

- Guard your passport
  - Expensive and time-consuming to replace overseas
- Pack supplies
  - Medicine and cosmetics
  - Stomach meds (anti diarheal / pepto)
- Food
  - Seated meals expensive and long in duration
  - Fast, cheap food in train station (sandwiches / pizza / dogs)
  - Bring water bottle (water is expensive, tap is fine)

Suggestions

- Consider pulling cash from ATM when you get there
- Visa / MC not accepted everywhere
- Clothes
  - Comfortable walking shoes
  - Shorts are ok in some cases
  - Lab tours may need pants and decent shirt, closed-toe
- Alarm clock + buddy system