SAUDI ARABIA ENERGY USE

ELIZABETH BROMM

KARA CLEGHORN

MATT BAPTISTA

ABOUT SAUDI ARABIA

- Located on the Arabian Peninsula
- Monarchy – King Salman
- 5th largest Asian country by area
- Population: 32.28 million (2016)
- World's largest oil producer and exporter
- GDP (PPP): $1.75 trillion (2017)

OIL PROFIT

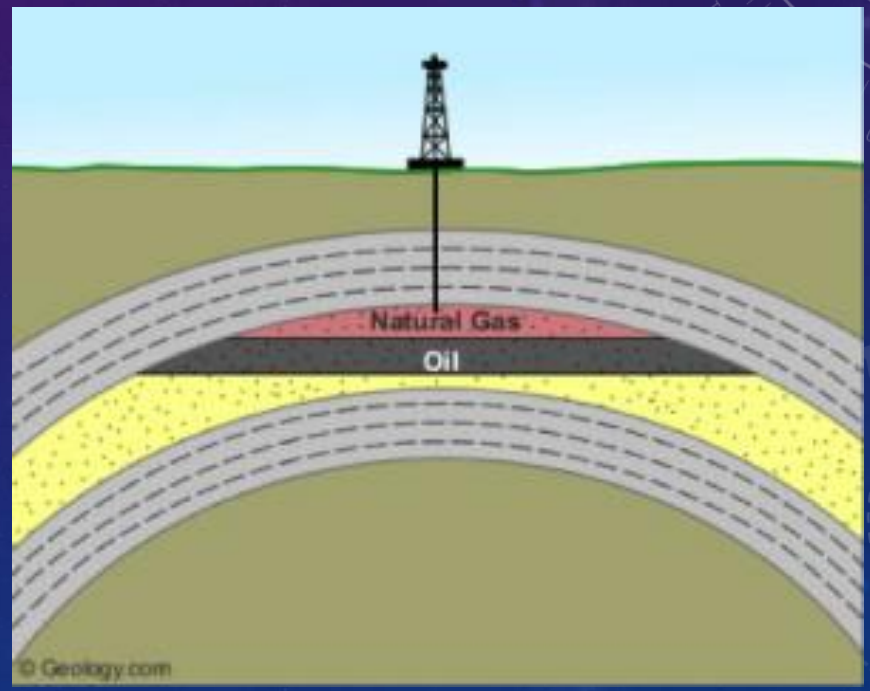
- Represents 1.04% of the world economy
- All time high in 2014 of $756.35 billion
- All time low in 1948 of $4.19 billion

WHO OWNS ELECTRIC

- Saudi Electric Company (SEC)
  - Government-owned company
  - Provide most of the electricity for the country
  - Generation cap of 69 GW (2015)
- Residential - 18 halalas per kWh
  - 30 halalas after 6000 kWh
  - 25 halalas = $0.07

WHO OWNS OIL AND GAS

- Saudi Aramco
  - Government-owned company
  - Manages oil and gas production
  - Works with SEC to provide power



WHAT ENERGY THEY USE NOW

- 60% of electricity relies on petroleum including natural gas, with the rest of their energy coming from solar (25MW) and geothermal (44MW)
- Use of solar and geothermal began in 2016
- First wind turbine built in January 2017
- Very little oil used
  - Make too much in exporting to use

HAWIYAH GAS PLANT

- Hydraulic turbine electric generator, also called a turbocharger, was lunched in a pilot demonstration in early 2015
- Converts normally wasted hydraulic energy to electrical power
- 300 kW of anticipated average energy output
- Goals for this technology include lower costs and reduced carbon footprint
- If successful, more turbochargers will be implemented

ENERGY BREAKDOWN AND COMPARISON TO USA

SAUDI ARABIA					
Gross Domestic Product	Energy Production	Electricity Consumption	Carbon Dioxide Emissions	Electricity per Population	Carbon Dioxide per Population
$672.21 billion 2010 USD	648.61 Mtoe	313.06 TWh	531.46 Mt	9.93 MWh/capita	16.85 t CO_2/capita
UNITED STATES					
Gross Domestic Product	Energy Production	Electricity Consumption	Carbon Dioxide Emissions	Electricity per Population	Carbon Dioxide per Population
$16597.45 billion 2010 USD	2018.53 Mtoe	4128.51 TWh	4997.50 Mt	12.83 MWh/capita	15.53 t CO_2/capita

FUTURE ENERGY PREDICTIONS

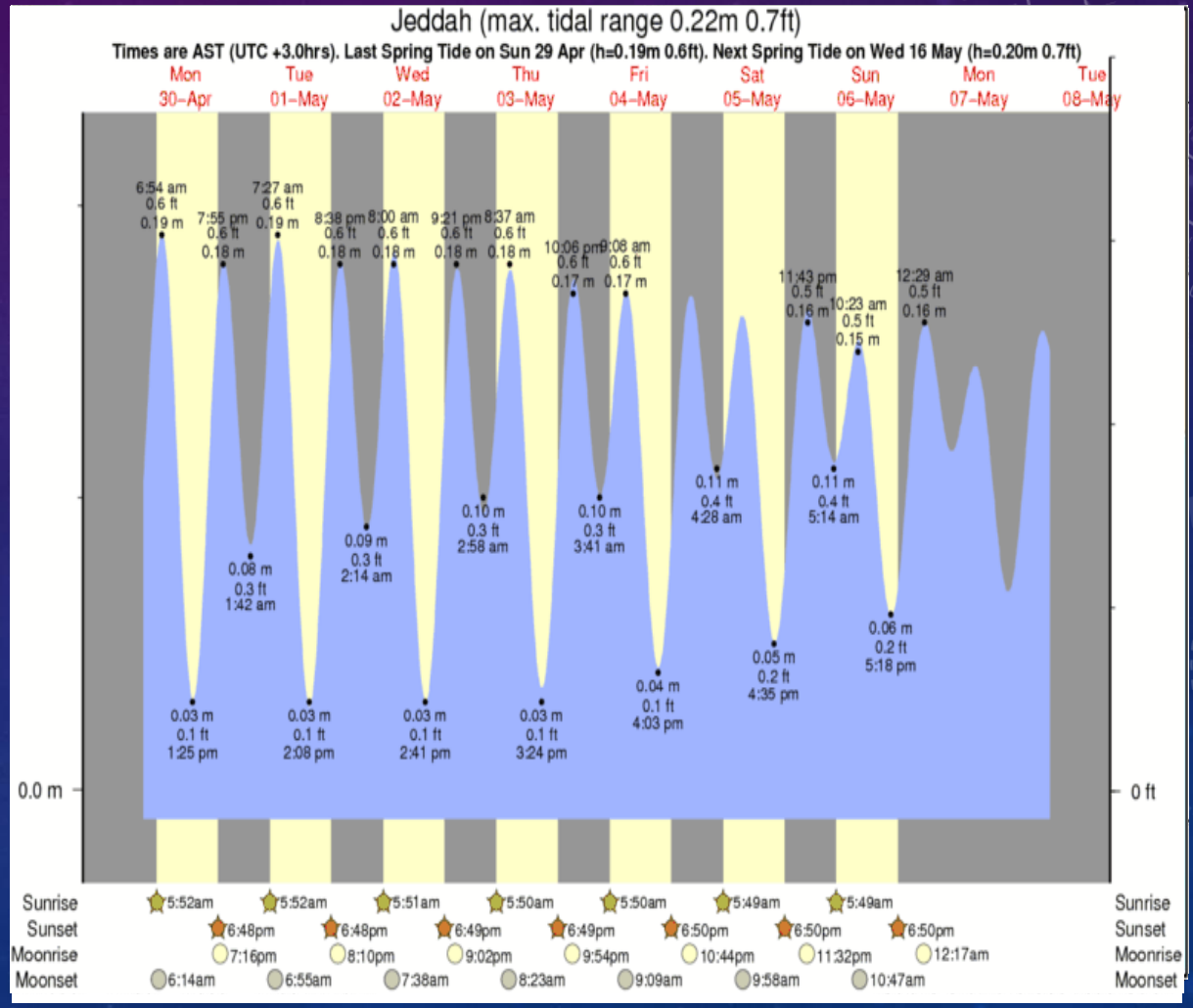
- Power generation capacity will need to expand from 77GW in 2014 to an estimated 156GW in 2040
  - This will require a yearly investment of approximately $5 billion in generation and $4 billion in distribution from the government
- All electric generation will be privatized by 2020
- Improving the country's energy efficiency by just 4 % per year could save the equivalent of 1 million barrels a day of crude oil by 2030

CHANGES ALREADY PLANNED

- To reduce energy waste:
  - Upgrade and replace old transformers, substations, and other infrastructure by 2023.
- To meet power demands:
  - Modernize the power grid and to increase connectivity
- To provide more energy sources:
  - Diversify the sources of energy used including adding more alternative and renewable forms of energy.
  - Installation of solar and wind power sources

RENEWABLE ENERGY OPTIONS

- ~~Hydro~~
- ~~Biomass~~
- Geothermal
- Wind
- Solar
- ~~Tidal~~

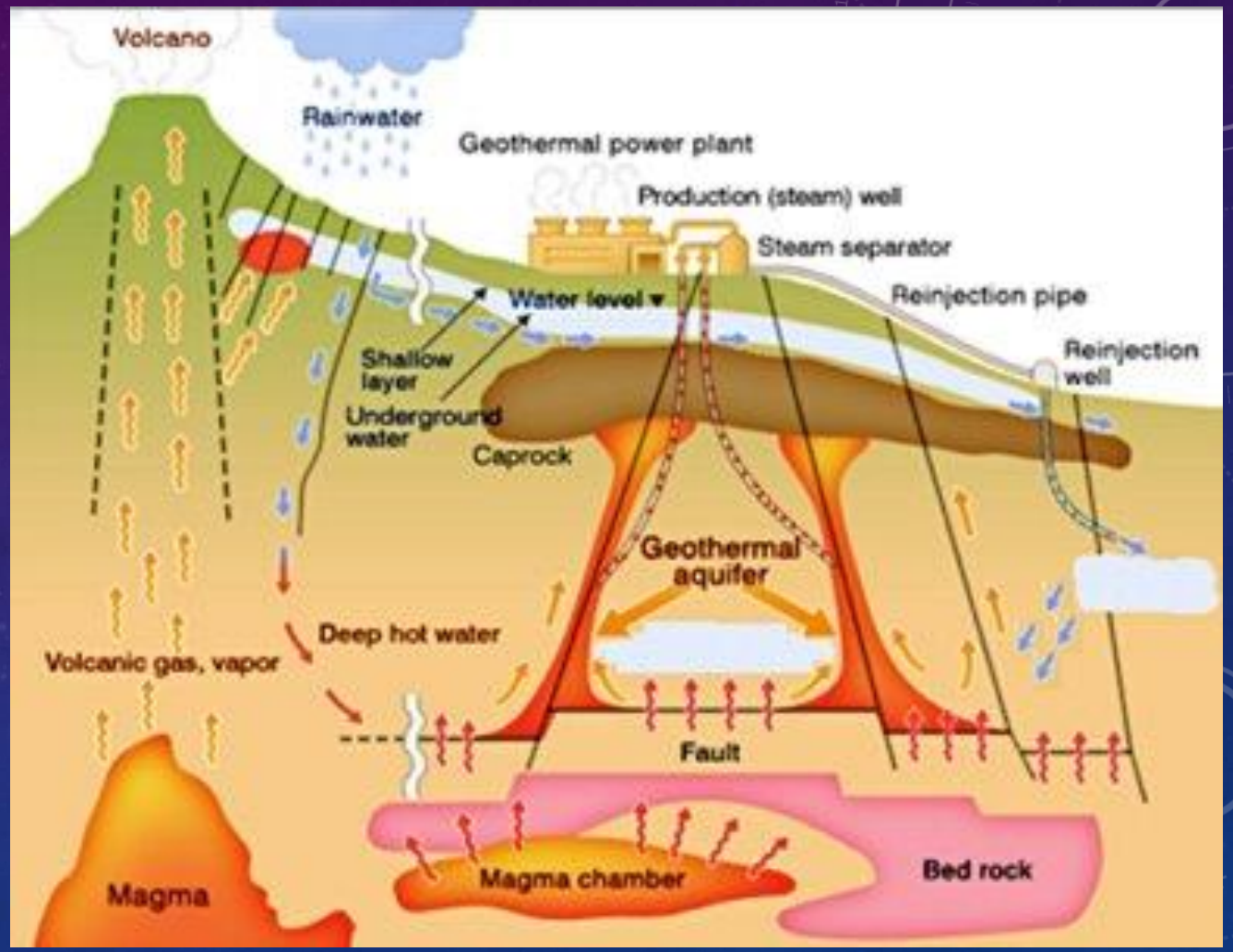


GEOTHERMAL

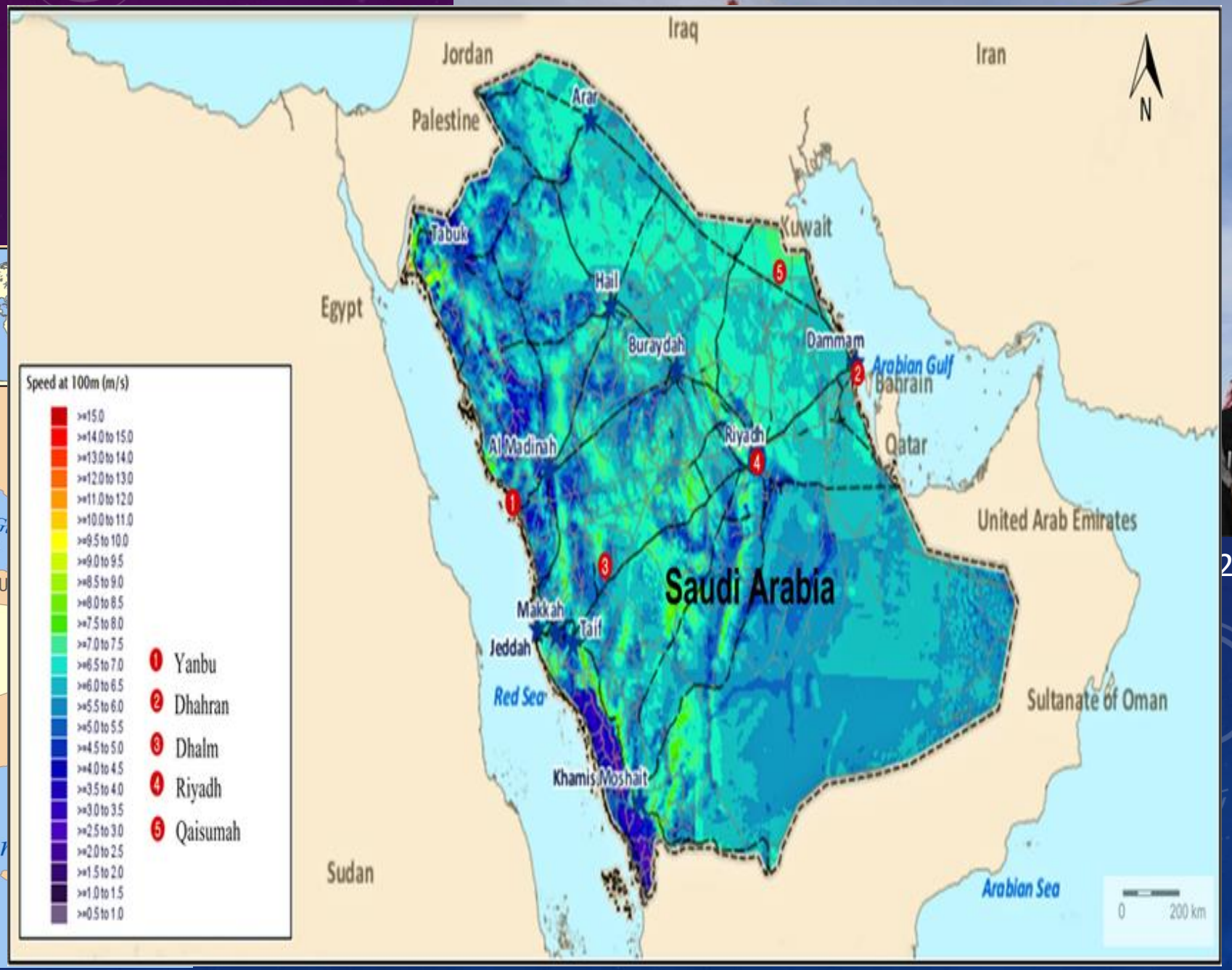
- Geothermal resource exploration started in 1980
  - Aramco
- Large volcanic fields
  - Western region near Jeddah and Makkah
- 10 thermal springs found around 120°C
  - 6 in Jizan
  - 4 in Al-Lith area

GEOTHERMAL

- Desired growth in global installed capacity
  - 10.5 GW to 31 GW by 2020
- Criteria – High Enthalpy
  - Geothermal Fluids <150°C
  - Near volcanic areas
  - Flow Rate <70 L/s



WIND ENERGY



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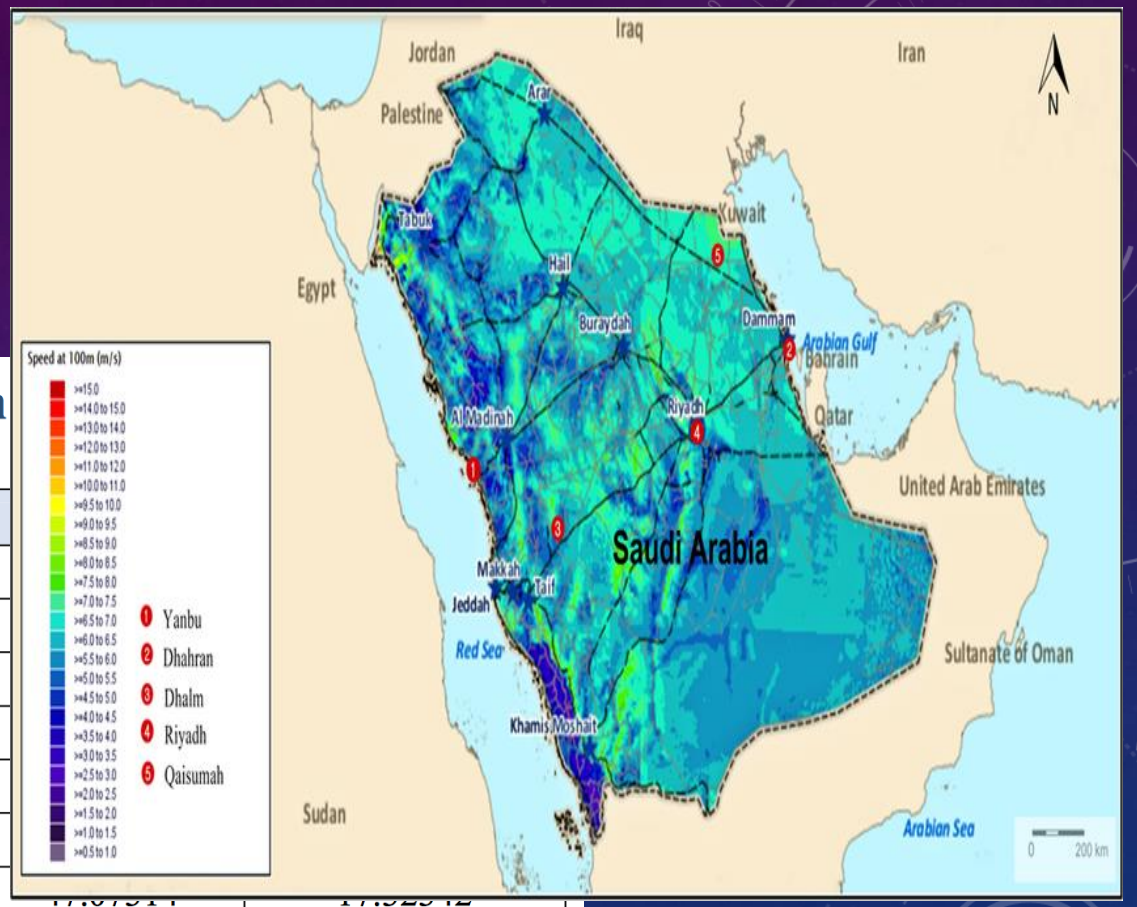
WIND ENERGY



Wind Observation Stations in

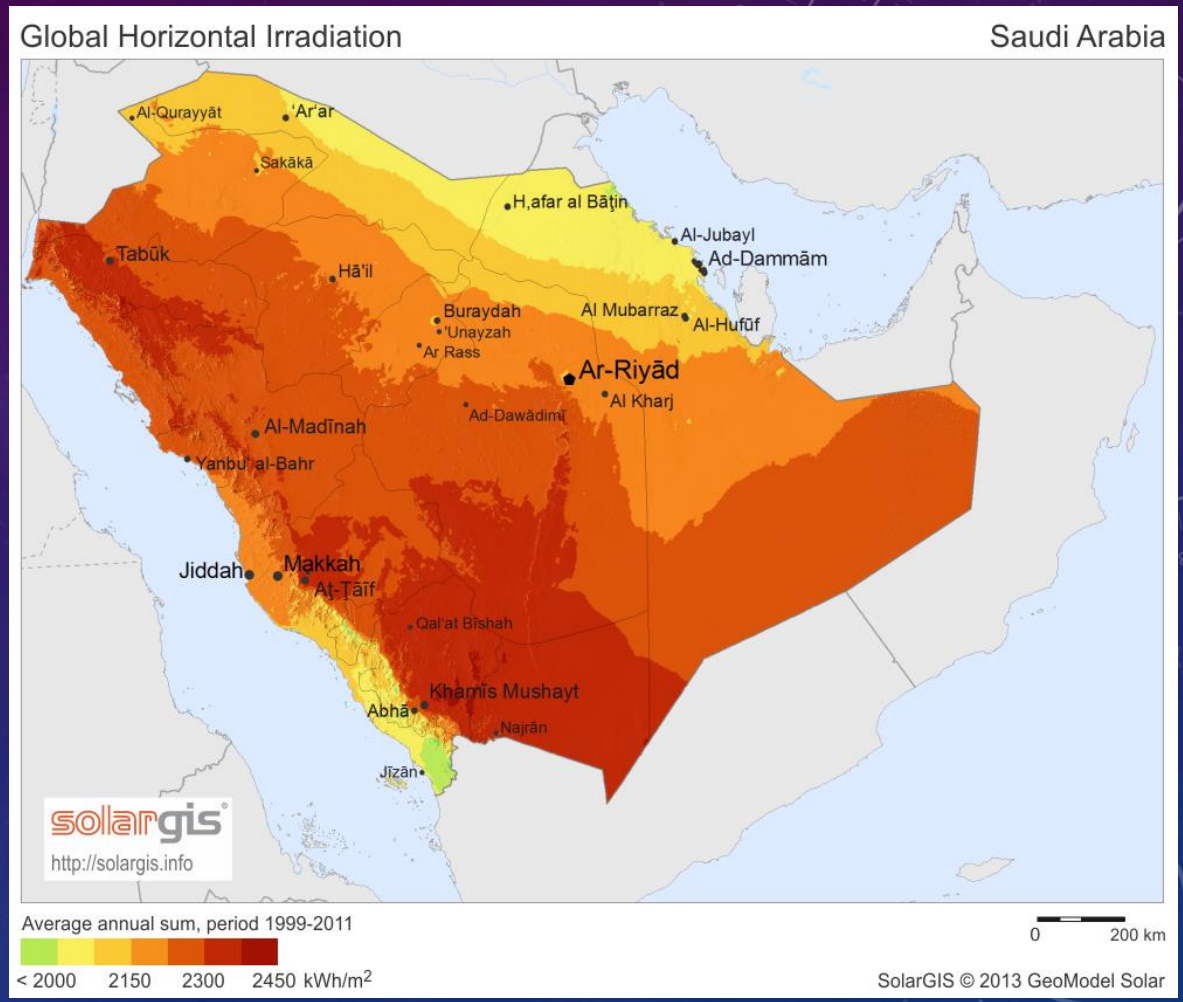
S/N	City	Stations		
1	Al Wajh	Al Saih		
2	Al-Jouf	Abu Ajram		
3	Hafar Al-Batin	Hafar Al-Batin		
4	Jeddah	AlJazeera		
5	King Abdullah City	Plant A		
6	King Abdullah City	Plant B		
7	Sharurah	Sharurah		
8	Turaif	Turaif	47.07314	17.32342
9	Yanbu	Yanbu Northern Plant	37.48445	24.34202
10	Yanbu	Yanbu Southern Plant	38.5026	23.78191

Source: King Abdullah City for Atomic and Renewable Energy (K.A.CARE)

Utilizing these wind stations, average windspeeds at 100 meters were the fastest at 6.73 m/s in 2016.

Utility-scale wind power plants require minimum average wind speeds of **6 m/s** (**13 mph**).

SOLAR ENERGY



THE COST OF RENEWABLE ENERGY

Renewable	Installation Cost	Energy Cost
Geothermal	$3400 per kilowatt	$0.01-$0.03 per kWh
Wind	$1.3-2.2 Million per MW	$0.082 per kWh
Solar	$1 per watt	$0.122 per kWh

MOVING FORWARD...

- Saudi Arabia already has plans in place to implement renewable energy. These plans include
  - Geothermal
    - Expected power output 10.5 GW to 31 GW by 2020
  - Wind Energy
    - Expected power output 400-megawatt wind plant by 2030
  - Solar Energy
    - Expected power output 300 MW for the new photovoltaic project set to begin use in 2018
- The total power output from these changes is 31.7 GW

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