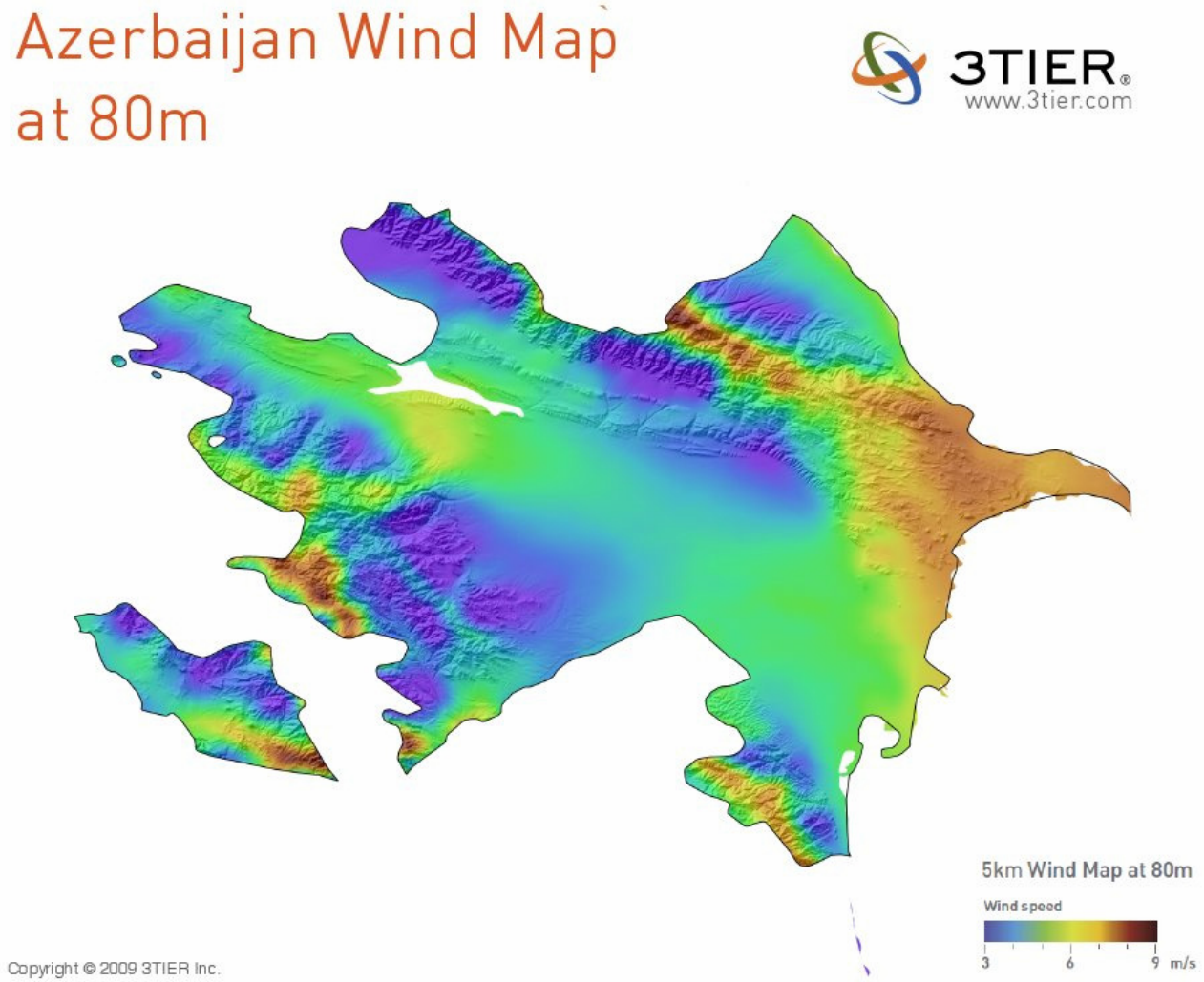
Context for Azerbaijan

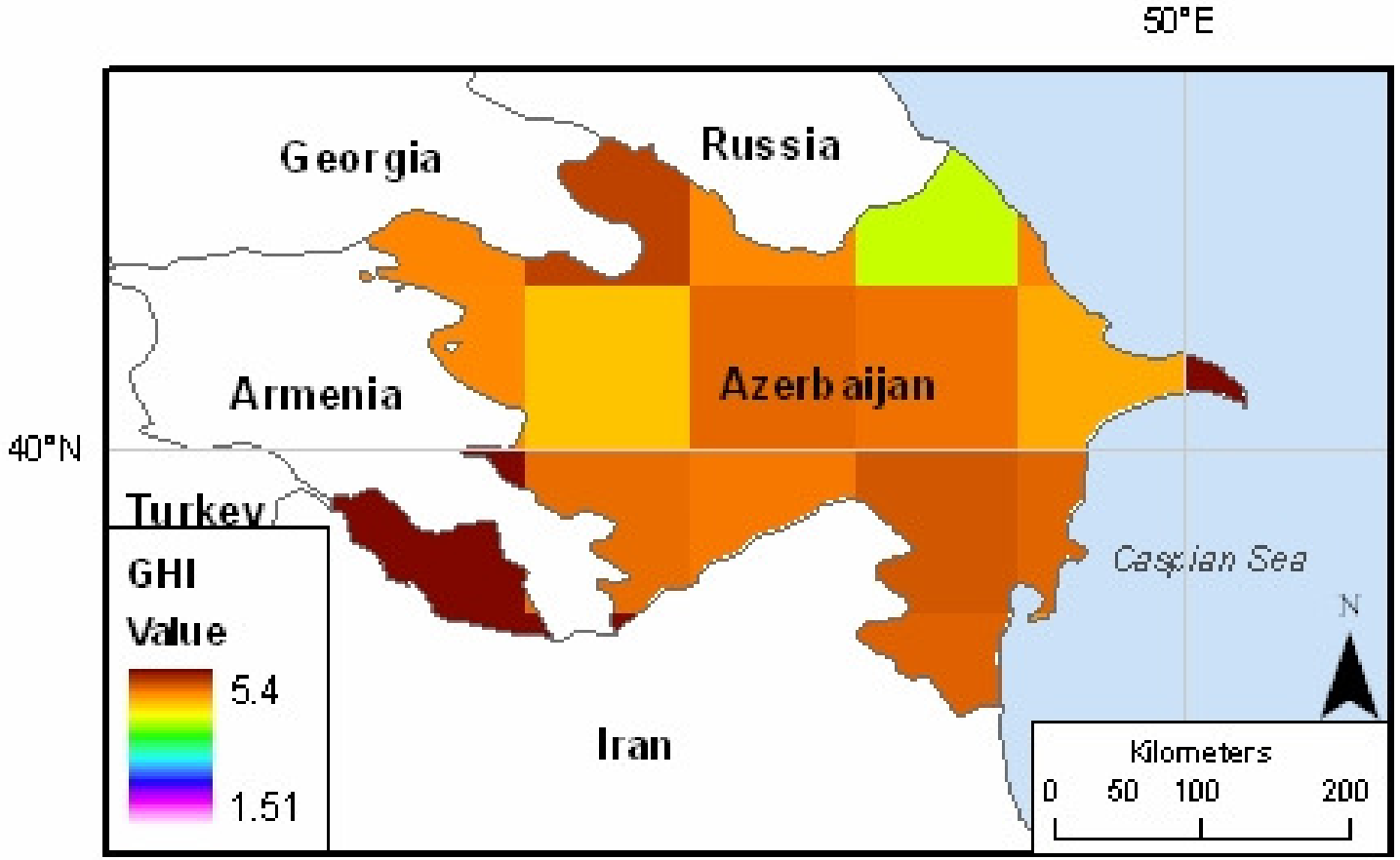
Renewable energy resources

- Azerbaijan is blessed with rich energy resources
  - Fossil fuel and renewable
- It is already energy independent due to reserves of oil and gas
- Many countries are turning their energy strategies towards developing greater penetration of renewable energy
- Azerbaijan has an opportunity to create significant wealth by generating greater levels of renewable energy and exporting fossil fuels for revenue

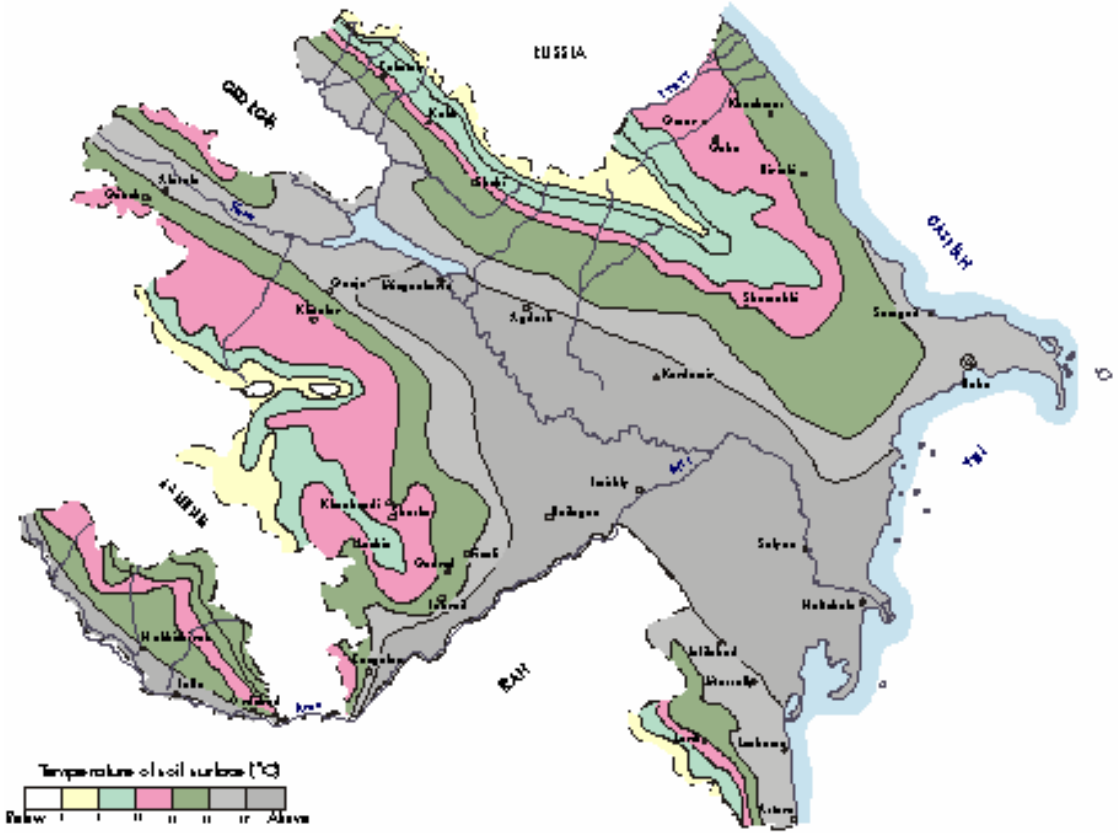
Some renewable energy resources in



- Solar Global Horizontal Irradiance



- Geothermal Resource



Absolute maximum and minimum of temperature of soil surface

Station	Absolute Maximum	Absolute Minimum
Zakatala	41	-4
Khachmaz	47	-4
Kuba	41	-4
Shamakhi	41	-4
Saatlakh	41	-11
Mashtagi	41	-1
Kharlanair	41	-1
Ashura	41	1
Khachmaz	41	-7
Nakhchivan	41	-1

Temperature of soil surface on different height above level of sea

Height (m)	Absolute Maximum (South Slope)	Lenkoran	Talysh	Nakhchivan 3.0
100	41.1	41.1	41.1	-
200	41.7	41.7	41.7	41.7
1000	41.1	41.1	41.1	41.1
1000	41.7	41.7	41.1	41.1
1000	41.1	41.1	41.1	41.1
1000	41.1	41.1	41.1	41.1
1000	41.1	41.1	41.1	41.1
1000	41.1	41.1	41.1	41.1
1000	41.7	41.7	41.7	41.7
1000	41.1	41.1	-	41.1
1000	41.1	41.1	-	41.1
1000	41.1	41.1	-	41.1
1000	41.1	41.1	-	41.1

- Hydroelectric Resource
  - Kura River
  - Aras River
  - Tributaries

- Of all the renewable energy technologies, only tidal power has no significant potential application in Azerbaijan
- The Caspian Sea has insufficient tides to drive marine current turbines or to be captured in tidal barrages

- Wind speeds are greatest along the east coast of Azerbaijan
- The Apsheron Peninsula has highest wind speeds
- The EBRD suggested 3000MW of wind power could be installed
- This is likely to be constrained by site availability
- Detailed mapping and prioritisation of sites for wind farm development would be recommended

- Azerbaijan is also rich in geothermal energy
- Temperatures of around 90oC at depths of 1400m have been recorded
- This suggests a significant potential for geothermal energy used to generate electricity
- One estimate suggests the national resource is 4m litres of hot water per day

- Solar energy is applicable throughout the country, both at small scale and large scale developments
- Solar insolation per year averages 1715 kWh/m2 in Azerbaijan
- This compares to around 1000 kWh/m2 in Northern Europe where solar power is extensively used

- Biomass is a significant but localised resource in Azerbaijan
- This includes wastes from cotton and cereal growth, animal wastes, energy crops, forestry, municipal wastes etc
- The EBRD suggests that 1000 tonnes of oil equivalent resource is available across Azerbaijan
- This equates to a generation output of 11,630 MWh per year
- Such a low figure must fail to take account of potential for energy from waste
- Scientific analysis of the resource is urgently needed to estimate a reliable resource potential

- Perhaps surprisingly, wave energy could be developed along the shores of the Caspian Sea
- The level of this resource needs to be investigated
- It is likely, given average wind direction, that the optimum location for wave converters will be on the northern shore of the Apsheron Peninsula

- Placed together, Azerbaijan has a geographically widespread supply of renewable resources
- Wind and tidal are in the east
- Solar is widespread
- Hydro is in the Kura and Aras valleys and in mountain valleys
- Biomass is widespread and an option especially suited to rural areas
- Geothermal is in the lowlands

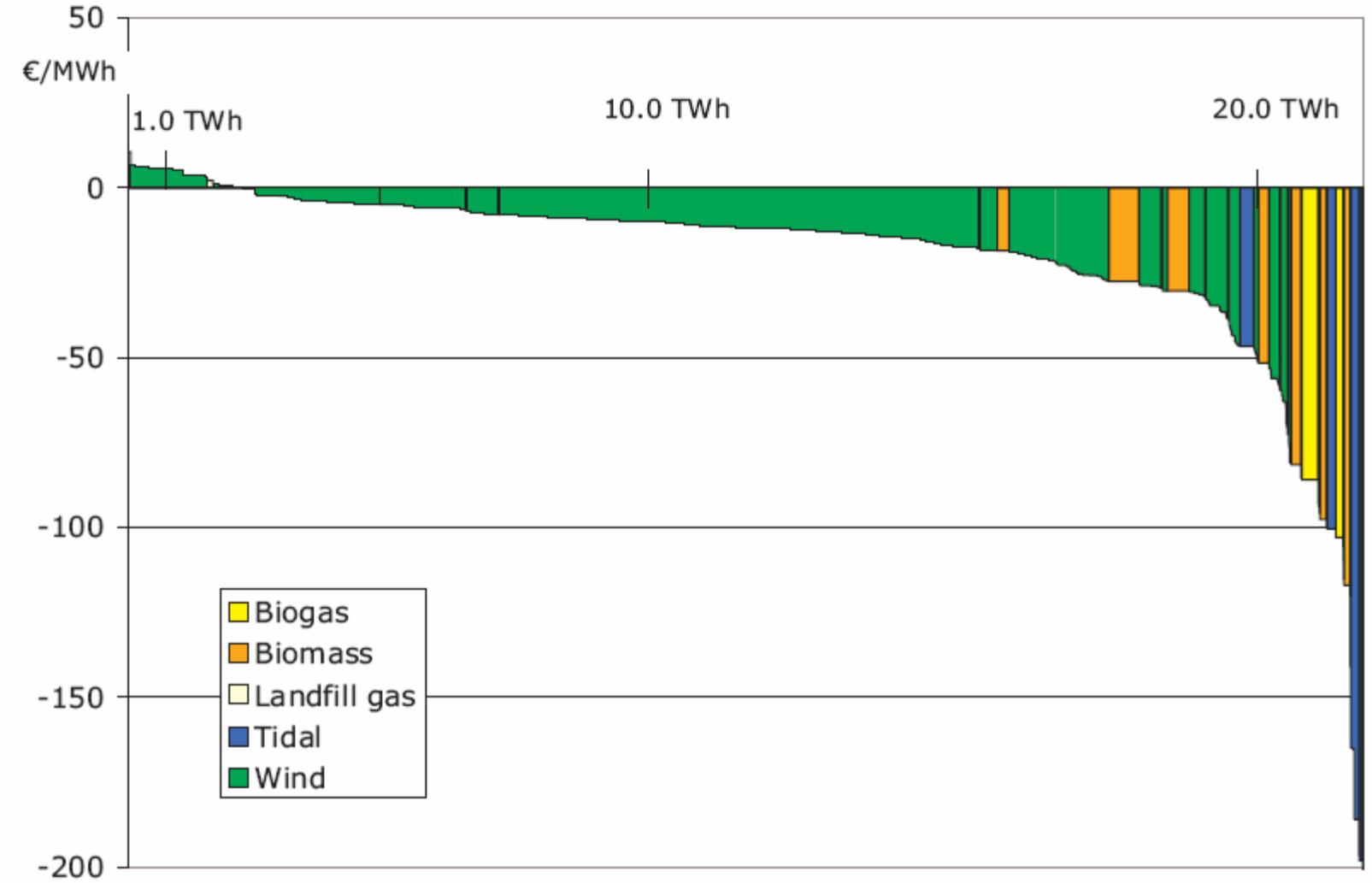
Levelised costs

- In order to priorities investment in renewable energy technologies, it is useful to determine levelised costs
- Levelised costs per kWh of electricity generation include the costs of construction, annualised costs for operation and maintenance and the costs of grid connection

How do renewable energy technologies compare?

- The levelised cost of renewable energy technologies varies greatly, depending on the economics of the location
- For comparison, the Irish Grid Study in 2007 looked at numerous proposed sites for renewable electricity generation and produced a priority based on cost
- Of course, cost is not the only driver for renewable energy development, and technologies such as wave and tidal power are being adopted in Ireland

Profit resource curve for Ireland with 42% renewable electricity



Levelised costs in Ireland

- Wind has a levelised cost per kWh starting from €0.04.
- The study showed that 4000MW of wind could be installed for a levelised cost less than €0.06 per kWh
- Second most economic is biomass
  - Levelised cost of electricity from landfill gas is from €0.04 per kWh
  - Incineration of municipal solid waste is €0.06 per kWh
  - Burning energy crops and wood has a cost of €0.07 per kWh
  - Anaerobic digestion has a cost of €0.09 per kWh

- Wave and Tidal Stream technologies
  - The levelised costs were calculated at being over €0.10 per kWh
  - The most favourable sites for wave power had levelised cost of electricity supply at €0.104 per kWh
  - The most favourable site for tidal power had levelised cost of electricity supply at €0.10 per kWh for second generation devices

- Geothermal Energy, Small Hydro and Solar Power were not analysed in the Irish study
- Other sources estimate the following levelised costs:
  - Small hydro = from €0.034 per kWh
  - Concentrating Solar Thermal Power = from €0.053 per kWh
  - Deep Geothermal Power = from €0.055 per kWh
  - Large scale Photovoltaics = from €0.075 per kWh but generally higher

Applicable Technologies Recommendations

- There has been significant work already in terms of analysing the renewable energy resource in Azerbaijan
- What is needed:
  - More scientific studies on natural resource and potential for renewable energy across Azerbaijan
  - Site identification for renewable energy technologies based on the resource
  - Identification and prioritisation of those technologies based on levelised costs

- Thank You
- Any other questions?

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