Climate Resilience in Green Energy Systems

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Building Bi-regional Partnerships for Global Challenges

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1. Growing importance of adaptation

- Traditionally, the energy sector is related to mitigation.
- Global trend towards climate change adaptation
- Africa experiences strong impacts from climate change
- Changing weather trends indicate the urgency

→ Hydropower

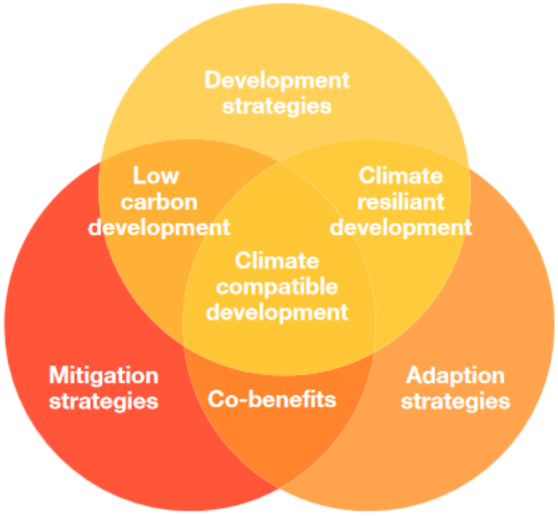
Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Burundi								D	D	D				
Djibouti									D	D				
Eritrea						D	D		D	D	D	D	D	D
Ethiopia	D	D		D			D		D	D	D	D	D	D
Kenya		D	D				D	D	D	D	D	D	D	D
Rwanda					D	D		D	D	D				
Sudan					D		D			D	D	D	D	D
Tanzania		D					D	D	D	D		D	D	D
Uganda							D		D	D	D	D	D	

D = Year in which there was a significant rain shortage in agriculturally productive areas

Source: World Bank, 2005

1. Growing importance of adaptation

- Co-benefits for adaptation and mitigation



Climate compatible development (Adapted from Mitchell et al., 2010)

- Two sides to adaptation in the energy sector:
  - energy systems to support adaptation
  - climate proofing energy systems

2. Renewable energy as a solution to adaptation

- Case: Grundfos Lifelink project in Kenya
  - 2009 - present
  - **Objective**: provide sustainable access to safe water
  - 16 million people without access to water
  - **Solution**: adapted pump technology to make solar water pumps

3. Climate proofing energy systems

Energy sector vulnerabilities to climate change (Ebinger et al., 2011)

Item	Relevant climate impacts			Impacts on the energy sector
	General	Specific	Additional	
Climate change impacts on resource endowment				
Hydropower	Runoff	Quantity (+/-) Seasonal flows high & low flows Extreme events	Erosion Siltation	Reduced firm energy Increased variability Increased uncertainty
Wind power	Wind field characteristics, changes in wind resource	Changes in density, wind speed Increased wind variability	Changes in vegetation (might change roughness and available wind)	Increased uncertainty
Biofuels	Crop response to climate change	Crop yield Agro-ecological zones shift	Pests Water demand Drought, frost, fires, storms	Increased uncertainty Increased frequency of extreme events
Solar power	Atmospheric transmissivity	Water content Cloudiness Cloud characteristics	Pollution/dust and humidity absorb part of the solar spectrum	Positive or negative impacts
Wave and tidal energy	Ocean climate	Wind field characteristics No effect on tides	Strong nonlinearity between wind speed and wave power	Increased uncertainty Increased frequency of extreme events
Climate change impacts on energy supply				
Hydropower	Water availability and seasonality	Water resource variability Increased uncertainty of expected energy output	Impact on the grid Wasting excessive generation Extreme events	Increased uncertainty Revision of system reliability Revision of transmission needs
Wind power	Alteration in wind speed frequency distribution	Increased uncertainty of Energy output.	Short life span reduces risk associated with Climate change Extreme events	Increased uncertainty on energy output
Biofuels	Reduced transformation efficiency	High temperatures reduce thermal generation efficiency	Extreme events	Reduced energy generated Increased uncertainty
Solar power	Reduced solar cell efficiency	Solar cell efficiency reduced by higher temperatures	Extreme events	Reduced energy generated Increased uncertainty
Thermal power plants	Generation cycle efficiency Cooling water availability	Reduced efficiency Increased water needs, for example, during heat waves	Extreme events	Reduced energy generated Increased uncertainty
Oil and gas	Vulnerable to extreme events	Cyclones, floods, erosion and siltation (coastal areas, on land)	Extreme events	Reduced energy generated Increased uncertainty

3. Climate proofing energy systems (cont.)

- Two overall strategies:
  - Diversify the sources of energy
  - Climate proofing the energy infrastructure

  → What about existing energy infrastructure?
- Necessary preconditions to reduce risks:
  - Availability of relevant information
  - Institutional development

  → Need for linkages between academia, private and public sector, and decision makers

3. Climate proofing energy systems (cont.)

- Case: Geothermal development in Kenya
  - Relied heavily on hydropower
  - 1999-2002 droughts reduced hydro-generated electricity capacity by 25%
  - Geothermal power = overcome impacts from droughts
  - Comparable to hydro - baseline supply

3. Climate proofing energy systems (cont.)

3. Climate proofing energy systems (cont.)

- Supported by the Ministry of Energy, Kenya
- Official target is to cover 25% of total power capacity by 2020
- Already surpassed, approaching 50%
- During droughts the plants perform at almost 100% and partially cover the loss in electricity
- Modular technology - can scale up

4. Research/knowledge gaps

1. Risk management under climate uncertainty.
2. Climate change and meteorological data for Africa.
3. Climate proofing existing energy technology.
4. Holistic approach to impacts from climate change adaptation in energy systems
5. The 2030 energy related Sustainable Development Goal

4. Research/knowledge gaps

1. Sustainable business models
2. Modelling global energy flows and trade
3. Projecting energy demand
4. Understanding possibilities for energy transmission and distribution

5. References

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Thank you

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