Bioenergy and Sustainability

Current strategies, goals and work in South Asia

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Structure

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- What is Bioenergy?
- What is Sustainability?
- What are the connections between them in South Asia?
- Goals of bioenergy technologies
- Strategies to address these goals
- What is happening towards this strategy implementation?
- Way Forward

Bioenergy?

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- What is bioenergy?
  - **Energy from trees, plants,crops or from human, animal, municipal and industrial wastes**
  - **Woody and Non Woody Biomass**
    - Woody - derived from forests, plantations and forestry residues
    - Non Woody - comprises agricultural and agro industrial residues, and animal, municipal and industrial wastes

What is Sustainability?–
Sustainability Framework

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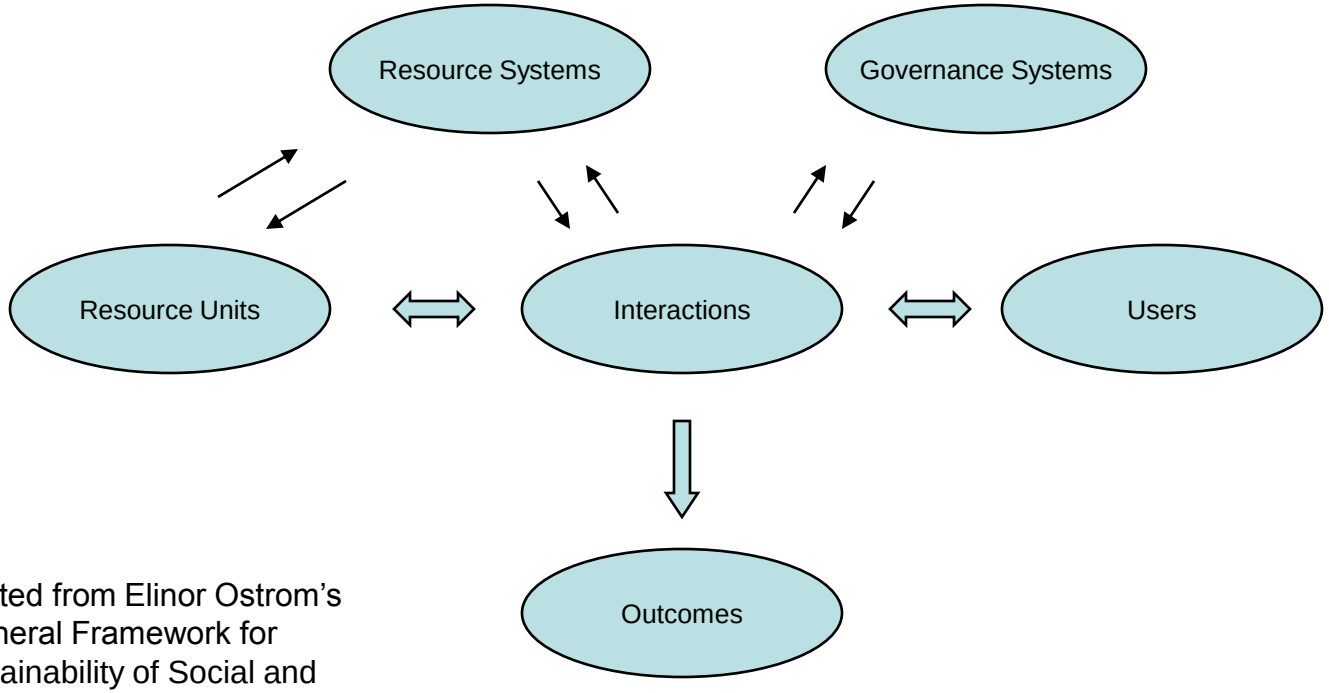
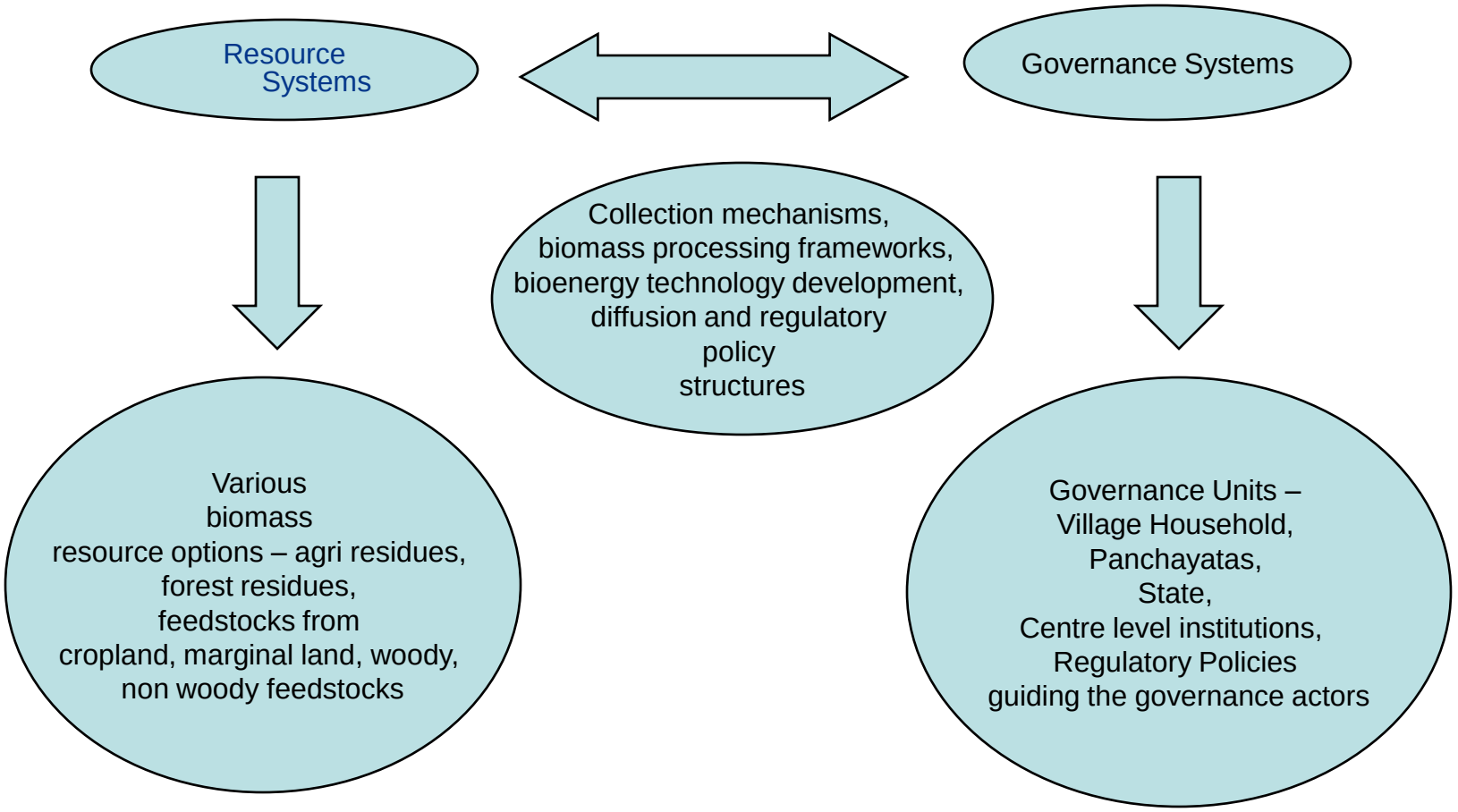
- Bruntland Commission Definition?
- In a social, economic, legal and political setting –



Source – Adapted from Elinor Ostrom's work on "A General Framework for Analyzing Sustainability of Social and Ecological Systems", Science 325, 419 (2009);

What are the connections between them in South Asia?



To illustrate the connection - Biogas and sustainability

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- Biogas for cooking – eliminates smoke for cooking
- Biogas for cooking – reduction in depletion of natural resources
- Biogas slurry – as a farm manure – improvement in soil conditions, enrichment of the soil with manure and organic matter

Goals

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- For meeting local needs
- Usage of bioenergy for meeting transportation requirements
- To use as a clean energy and livelihood generation option
- To meet sustainability goals – social, environmental domains largely

Bioenergy for what purposes in South Asia

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- Cooking, Lighting, Heating, Operation of Kilns, Transportation, Milling, Motor Usages
- Biomass combustion and gasification for electricity
- Biomethanation for cooking energy (gas) and electricity
- Efficient wood-burning devices for cooking
- Liquid biofuels for local usages and transportation

Potential sources for biomass in South Asia

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- Wasteland
- Agricultural Residues
- Forest Wasteland - forest, forest tree twigs, forest wastes, plantation, farmlands, homesteads, degraded lands and shrubs
- Marginal Cropland
- Crops – Rice, Maize, Cotton, Sugarcane
- Dung – Cattle, Buffalo - cattle dung, leaf litter and woody biomass as the feedstock, biogas can be used for cooking
- Oil bearing seeds, crops - Jatropha curcas, Neem, Mahua, Wild Species, Sweet Sorghum, Rice Bran, Neem, Sal, Karanja

Hierarchy pattern of biomass energy use in South Asia – **Fuelwood followed by cattle dung and agro-waste**

What are the bioenergy forms in South Asia?

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- Energy forms which are available –
  - **gaseous (biogas, producer gas)**
  - **liquid (ethanol, methanol, biofuels)**
  - **solid (briquette) fuels**

Snippets of Bioenergy Technologies in South Asia

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- Biopower – Cogeneration systems using and employing biomass direct combustion
  - **Utilisation of agricultural wastes**
- Improved Biomass Heating - stoves, kilns, ovens and furnaces for cooking and space heating in households
  - **process heating in SMMEs**
- Gasifier technology for thermal and electricity generation – China, India main players
  - **Sri Lanka has pilot-commercial "dendrothermal" systems using integrated tree plantations for gasifier based power plants**
    - off-grid and grid-connected operations gliricidia trees intercropped with coconut and tea – Bangladesh, Myanmar and Nepal also doing the same
- Biogas – China, Nepal Biogas Support Programme (has the support of rural based micro lending facilities)
  - **In Nepal - Fifty private biogas companies - sell, manufacture and install the systems after-sales support, maintenance and repair services**
  - **Nepal has 75% subsidy provision for family scale biogas plants**
  - **In Nepal, China – biogas has developed to the commercial scale**

Bioenergy – Work Done/ Ongoing

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- Cooking - efficient cookstoves, biogas and methanol
  - **Cookstove options in South Asia**
    - fixed-type cookstoves, portable cookstoves, high-altitude metallic cookstoves
      - Efficiency 20% for fixed cookstoves
      - Over 25% for portable ones
      - Improved Cookstoves –
        - » complete combustion of the fuel
        - » minimum amount of excess air
        - » maximum transfer of heat from the flame and the flue gases to the cooking vessel,
        - » minimum loss of heat to the surroundings

Biomass Gasifier Stoves – Work Done/ Ongoing

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- Compact gasifier– gas burner devices
  - **since the mid-nineties for cooking applications**
  - **biomass gasifier cookstoves in China, India, Srilanka**
  - **efficiency of these gasifier stoves is in the range of 25–35%**
    - Producer gas is polluting and has health effects
    - Currently work is done in South Asia to reduce the health implications of the producer gas by controlling the CO content of the producer gas

Biomethanation - Work Done/ Ongoing

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- Biogas models – Chinese (fixed dome structures), India, Srilanka, Pakistan, Bhutan (floating dome)
- In India, biogas plants are operational – 3.83 million biogas plants have been built against a potential target of 17 million
- There is an underachievement in covering villages
- Biomass conversion technologies can help in meeting energy needs – for instance the demand from electricity
  - **Key technologies in South Asia – For power generation - gasification, combustion, cogeneration and biomethanation**

Biomass Gasification – Work Done / Ongoing

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- Gasifiers are – updraft, downdraft and cross draft depending on the direction of airflow
- Range of capacity of gasifiers – 1kg/ hectare to 500 kg/ hectare
  - **Used for thermal and heating applications**
  - **diesel engines connected to alternators, where diesel savings to the limit of 80% are possible**
- small-scale gasifiers (of 20–500 kW) can meet the localized rural energy needs

Biomass Combustion – Work Done/ Ongoing

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- Similar to coal based thermal power generation technology
- Penetration has been low

Biomethanation - Work Done/ Ongoing

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- Biogas produced is supplied to a diesel engine, which is connected to an alternator
- Few demonstration projects
  - **Projects operating at the scale of 3–250 kW**

Work Done / Ongoing

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- Improved cookstove programmes in 1984 – 85 that reached peak in 1995 – 96 in India
- Penetration of bioenergy technologies has been marginal in comparison to the target inspite of large number of programmes
- Renewed Interest in Improved Cookstove Programme in South Asia

Work Done/Ongoing

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- Liquid Biofuels – Ethanol, Biodiesel
- Mandatory Policy Pushes for blending
- Small scale demonstration projects for local uses of biofuel from various non vegetable and vegetable oil seeds
- Penetration has been low inspite of programmes in place
- Technology diffusion in first generation feedstocks for biofuel
  - **Second generation not yet developed for a commercial scale**

Practical Considerations

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- alternative use of biomass as fodder or industrial raw material
- collection efficiency
- actual availability of so-called waste lands, forest lands and other types of lands
- availability of water, geographical and weather conditions

Work done as of now - Diffusion Experience of the technologies

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- Cookstoves –
  - **Stoves built by entrepreneurs trained by professional institutions**
  - **Technology made easily accessible to any interested stove builder**
  - **NPIC (National Programme for Improved Chulhas, India) failed, funding stopped, responsibility ICS passed to the states**
    - Few states, civil societies have been taking initiatives
      - Scaling up required, lack of funding, joint venture?, cost of importing technological equipments

Work Done as of now - Diffusion Experience of Bioenergy Technologies

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- Biogas, Biomethanation
  - **National programmes on Biogas Development**
  - **Floating Drum was promoted (a portable model made of rubberized nylon fabric)**
    - plant cost was very high, high fabrication cost
    - constant painting of metal gas holder to reduce corrosion
    - latest technology - fibre reinforced plastic gas holder
  - **R&D on biogas plants with leafy biomass**
    - Experimentation is on for this type of technology demonstration

Status of bioenergy technology diffusion

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- Biogas plants –
  - **focused R&D, pilot testing and evaluation**
  - **including prototype production, demonstration and evaluation, capacity building and manufacturing**
  - **R&D groups – developing programmes and a number of designs of varying capacities**
  - **Technology is still evolving –**
    - designs are approved by the ministry for technologies
    - licensing is a major mode of transfer
  - **Journey started with decentralized stand-alone systems to application of biomass gasifiers for power generation**
  - **Scale of the capacity - 3–500 kW**
  - **In some places connection to local grid is also available (5 units of 100 Kw – Gosaba – Sunderbans)**
- Future - Advanced Biomass - gasification involving gas turbines in the combined cycle mode
- Biooil Technologies – R&D going on to develop technologies for commercial scale of production

Stages of bioenergy based technology diffusion

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- R&D by technical institutions
- Establishment of specifications and standards
- Testing and certification, demonstration, dissemination and accelerated diffusion through other policy measures and incentives

Learnings from the work done

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- Lower industry involvement
- Demonstration, dissemination, risk sharing (subsidy), technical assistance and awareness
- Difficulty in standardising technologies due to problems in standardising software and hardware elements of the technology
  - **For biogas, chulhas – burners, pipes can be standardised but for improved chulhas – there is a need to standardise skill sets and use, maintenance of systems**
- Subsidy went into creating the real demand, initial technology penetration
  - **But subsidy could not ensure the replicable demand**
  - **NGOs and Local institutions are engaged**
  - **Indirect participation by the private sector**
  - **Levelised cost of bioenergy based power generation varying between Rs2.15 to Rs6.09 kWh2**
- Need for market transformation - Technology adaptation, enterprise technological capability, incentive measures, command and control measures, consumer education,
  and marketing

Learning from the work done – Barriers

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- Lack of capacity to understand, adopt and adapt the technologies
  - **Capacity constraints**
  - **Limited manufacturing capacity**
- Inadequate information
- Weak institutional infrastructure to provide after sale support
- High first costs and investments for mass scale manufacturing
- Limited R&D funding, incentives to the ones specific to certain central ministry standards
  - **No initiatives to alter these standards**
- Subsidies for conventional technologies
- End Use demand – fuel replaced by these technologies are available at subsidised rate
- Lack of partnerships with private sector
- Most enterprises were first generation entrepreneurs with weak financial and technical resource bases
- Constraints in biomass sources, production, transportation, conversion and end-use
  - **policies, institutions and financing play catalytic roles in technology transfer and diffusion of BETs**

Learning from the work done - environmental benefits

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- Cookstoves –
  - **GHGs per gram - 20–110% - CO and CH4, non methane hydro carbons**
  - **Fuelwood from non sustainable source – net emission of CO2**
    - 40% of the fuelwood is from non sustainable resources
  - **Biomass Gasifier**
    - CO2 emission reduction

Policies that have been place

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- Income tax holiday
- Accelerated depreciation
- Concessional duty/custom duty free import, soft loans for manufacture and state level policies

Way Forward

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- Training programmes for creating pool of skilled personnel
- Entrepreneurship Development
- Effective Monitoring and Evaluation for quality control
- Economic/Financial Viability by means of pilot projects, transparent feasibility studies, prototype business plans
- Coordinated R&D policies
- Incentives for private sector participation
- Development of information package in technologies and subsequent dissemination to entrepreneurs, end-users, policy makers, manufacturers

THANK YOU