FOOD FORWARD NDCs

Shifting to clean energy at the farm level

Overview

Agricultural and food systems consume about 30 percent of the world's energy. Emissions "within the farm gate" account for **7.2 billion tons** of greenhouse gas (GHG) emissions per year. Production of crops, livestock and fish at the farm level demands intensive energy use for fertilization, irrigation, watering, harvesting and vehicles and machinery. Shifting to clean energy improves energy consumption and reduces GHG emissions at the farm level. Adopting renewable energy also has the potential to reduce the environmental impact of food production, decrease food waste and foster affordable food prices. In addition to shifting energy sources, farms can implement electricity conservation practices, such as replacing old and energy-intensive devices, to increase energy efficiency.

Concrete measures to implement

Depending on national and local contexts and priorities, policymakers could implement the following measures to support farms shifting to clean energy:

- Promote the adoption and scaling of renewable energy technologies at the farm level depending on the energy source, as follows:
    - *Solar energy:*
        - solar photovoltaic panels and generators for:
            - pumping systems for irrigation and watering livestock

        - greenhouse or growth rooms management -i.e. ventilation, lighting, and heating-
        - precision agriculture – e.g. sensor networks
        - refrigeration or cooling systems for inputs and products
    - solar drying and roasting systems
    - tractors and other machinery propelled by solar energy from solar cells or panels
    - solar fertilization based on solar power, nitrogen and water from the air
- *Wind energy (*wind turbines):
    - electricity generation for batteries of farm machinery
    - water pumping from deep soil for large-scale irrigation and watering livestock
    - desalination systems
- *Biomass – Biowaste:*
    - combustion of sustainable biomass (residues from crop production and livestock) for running drying or heating systems, as well as other productive activities
    - use of biogas for agricultural engines and machinery
    - treatment of livestock waste or residues from crop production through collective biogas plant investments, especially in areas with small or medium-size farms
    - biowaste recycling and transformation into fertilizers to reduce the dependence on commercial fertilizers as they require high energy to be produced
- *Hydroelectric:*
    - install small hydro turbines to produce electricity
- *Geothermal:*
    - heat extraction from geothermal wells to be used for heating or drying systems

        - pipelines filled with hot water from geothermal reservoirs to control temperatures in greenhouses and open fields

- Develop national and local policies to accelerate adoption of renewable energy:

    - set up national and regional renewable energy strategies through inclusive multistakeholder processes including for raising finance for the agriculture and food sector
    - develop strategies to create investment opportunities to make renewable energy available and affordable for farmers, with particular attention to support low income and marginalised communities
    - examine energy and agricultural policies to find synergies for developing renewable energy projects in farms and reduce policy implementation costs

- Provide incentives to scale production and adoption of renewable energy technologies:

    - reduce regulatory barriers enabling the use of renewable energy technologies on farms
    - allow energy surplus produced to be delivered to the power or gas grids in exchange for favourable tariffs
    - provide long-term public financing or grants to enable farmers to purchase and pay for the maintenance of renewable energy technologies.

- Implement technical assistance and awareness programmes:

    - provide technical assistance to farmers to reduce the economic cost and knowledge barriers of integrating renewable energy technologies on farms
    - create inclusive training programmes through local institutions for farmers to increase management capacity to maintain renewable energy technologies (e.g. to handle drip irrigation systems) and to adopt skills and access markets for new products and higher yields for existing products, among other skills
    - promote adoption of energy efficient devices through media campaigns that raise awareness of energy and environmental

benefits.

Enabling governance measures

- Assess rural areas' current energy use and capabilities, as well as the potential of renewable energies and optimal type of renewable energy technologies in those locations. Incorporate behavioural insights into policies and programs. This would serve as the evidence-base for the design of concrete policy actions.
- Develop coordination and information platforms for public institutions, private actors, non-governmental organizations, and financing institutions to raise awareness of the national or regional strategies and raise funding or other resources supporting renewable energy actions.
- Encourage dedicated innovation funds and partnerships between local technology suppliers, research institutes and end-users to develop or repurpose existing technologies, and pilot them to test operational viability.
- Encourage established supply chains to deliver renewable energy solutions as well as long-term operational and maintenance services.

Tools and MRV systems to monitor progress

Calculators and Trackers

EX-Ante Carbon-balance Tool

The EX-Ante Carbon-balance Tool (EX-ACT) allows the estimation and tracking of outcomes of agricultural interventions on GHG emissions. Particularly, EX-ACT can measure GHG emissions reductions due to changes in energy technologies and devices.

Link: https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/

MRV Platform for Agriculture

The MRV Platform for Agriculture is a comprehensive platform with sample tools, measurement methods, software, and case studies for monitoring, reporting and verifying (MRV) GHG emissions in the agriculture sector.

Link: https://www.agmrv.org/

Toolbox on Solar Powered Irrigation Systems (SPIS)

Enables service providers, advisors, and practitioners in solar irrigation to offer guidance to policymakers, investors, and end-users. Toolbox includes informative learning modules and user-friendly software like calculation sheets, guidelines, and checklists.

Link: https://energypedia.info/wiki/Toolbox_on_SPIS

Guides and handbooks

FAO's INVESTA

FAO's "Investing in Sustainable Energy Technologies in the Agrifood Sector" (INVESTA) project offers a methodology for a comprehensive cost-benefit analysis of renewable energy solutions in the agri-food sector.

Link: https://www.fao.org/3/i9077en/I9077EN.pdf

Climate change mitigation benefits

Shifting to clean and efficient energy production and use at the farm level has potential to reduce GHG emissions in agricultural and food systems. The magnitude of GHG emission reductions will depend on the measures implemented and their scale. For example, solar-powered water pumping systems have 95 to 98 percent lower life-cycle emissions than equivalent pumps powered by electricity from the grid or diesel.

Adaptation benefits

- Sustainable food production
- Energy security
- Reduction of poverty and create green jobs

- Improve human health

Other sustainable development benefits

- Shifting to clean and efficient energy at farm level has positive impacts on several SDGs, namely:
    - SDG 6 (Clean water and sanitation)
    - SDG 7 (Affordable and clean energy)
    - SDG 8 (Decent work and economic growth)
    - SDG 11 (Sustainable cities and communities)
    - SDG 12 (Responsible consumption and production)

Main implementation challenges and potential negative externalities and trade-offs

- Lack of natural sources (e.g. sunlight or wind) required for renewable technologies
- High initial capital investment costs in clean technologies – this is a major challenge for small-sized and low income farmers, since clean energy costs are high compared to other technologies.
- Site-specific impacts on ecosystems and biodiversity due to the implementation of renewable energy technologies.
- Lack of knowledge about the renewable energy alternatives available to farmers and the costs and benefits associated with their implementation, which allow farmers to make informed investment decisions.

Measures to minimize challenges

- Consider cross-sectoral impacts of energy transition technologies, including renewables, on society and the economy to accelerate their adoption. Beyond traditional economic and environmental metrics, the effects of technology acquisition on water and land use, and the potential for competition for resources with agriculture and other end uses, should

be considered when defining transition trajectories at the national and regional levels.

- Implement hybrid systems relying on multiple sources (e.g. solar panels and wind turbines) to ensure a more reliable energy supply and minimize the risk of shortages.
- Use a combination of end-user financing (e.g. **grants, long-term credit, and tax exemptions**) to make renewable energies more affordable. Depending on local contexts, these can be integrated into existing rural financing networks and community organisations (e.g. co-operatives), with particular focus on supporting low income and marginalised communities.
- Invest in large-scale and centrally controlled photovoltaic or wind farms when demand warrants, as they could be financially and technically more efficient.
- Evaluate the suitability of options given the farm location, environmental conditions, and social factors.
- Adopt public policies with a value-chain approach that considers factors such as market linkages, availability of technical capacity and particular barriers for rural enterprises.
- Boosting responsible investments in clean energy infrastructure, services, and logistics can improve connectivity with rural areas, particularly areas with multidimensional poverty, to advance sustainablity and promote positive socioeconomic outcomes.
- Conduct an ex-ante assessment of the potential impact on environment of implementation of clean energy technologies and take mitigation measures.
- Conduct economic analyses (e.g. cost-benefit analysis) of planned measures.

Implementation costs

- The **upfront costs of renewable energy can be high** compared to conventional sources of energy. For example, individual solar pumps can be up to ten times more capital-intensive than conventional pumps of a similar size. However, life-cycle costs of renewable energy technologies are likely lower. In Senegal, for example, solar-powered irrigation systems can reduce operating costs by **40 to 50 percent per hectare relative to**

diesel-powered equipment and can increase farmers' income by at least 15 percent per hectare.

Intervention in practice

- There are examples of solar irrigation pumps displacing the use of fossil fuels and increasing both farmers' incomes and yields. For instance, in India, the use of solar irrigation has raised farmers' incomes by 50 percent compared to rain-fed irrigation. In Rwanda, smallholder farmers' yields have risen by about a third.
- The Australian Government, through the Clean Energy Finance Corporation, has invested more than AUD 60 million in some 1,100 agricultural projects ranging from solar photovoltaics to efficient farm equipment, machinery upgrades and bioenergy solutions.
- Water and Energy for Food (WE4F), a joint initiative between the German Federal Ministry for Economic Cooperation and Development (BMZ), the European Union, and other government development agencies, offers technical assistance, financial support, and investment facilitation for innovations in the water-food, energy-food, and water-energy-food domains globally. Through its Regional Innovation Hubs, WE4F supports smallholder farmers to unlock finance, technology, and inputs, as well as access to markets, and it assists farmers and food companies in reducing greenhouse gas emissions and enhancing climate resilience. Globally, WE4F-supported innovators impacted more than 920,000 smallholder farmers, of which 38 percent are women, with more than 400,000 end-users earning higher incomes by growing more food with fewer resources (e.g. energy, water).

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