FACT SHEET

Hybrid energy system

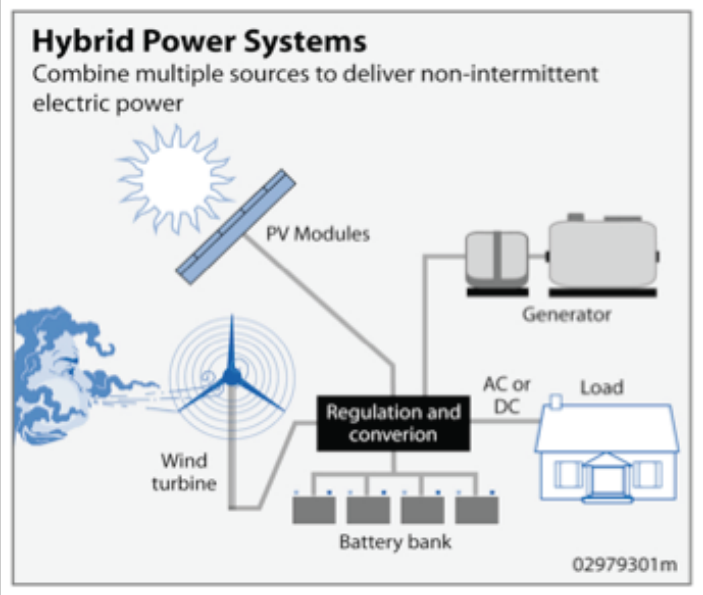
Key point

- ***Hybrid systems can increase the amount of dispatchable renewable energy generation as well as the reliability of rural energy access.***

Hybrid energy system explained

A hybrid energy system combines multiple types of energy generation and/or storage or uses two or more kinds of fuel to power a generator. A hybrid energy system is a valuable method in the transition away from fossil fuel-based economies. Particularly in the short term, while new technologies to better integrate renewable energy sources are still being developed, backing up renewable generation with conventional thermal electric production can actually help expand the use of renewable energy sources.

Figure 1: Hybrid power systems



Source: US Department of Energy, *Small "Hybrid" Solar and Wind Electric Systems* (Washington, D.C., US Government, 2011).

How it works

Hybrid energy systems can capitalize on existing energy infrastructure and add components to help reduce costs, environmental impacts and system disruptions. Planning a hybrid electricity system has a market focus rather than a technology focus: the priority is to choose a mix of energy technologies that is the most efficient and reliable way to meet users' needs.

Generally, at least one source of the fuel used to power a generator is renewable. Such a system is designed to increase the reliability (and thus usability) of renewable energy sources by providing redundant energy production from conventional sources or, more efficiently, by providing storage for electricity produced by intermittent sources.[1] Computer applications automatically increase or reduce conventional generation or battery usage as

[1] Gary D. Burch, "Hybrid renewable energy systems", presented at the United States Department of Energy Natural Gas and Renewable Energy Workshops, Golden, Colorado, 21 August, 2001. Available from www.netl.doe.gov/publications/proceedings/01/hybrids/Gary%20Burch%208.21.01.pdf (accessed 17 October 2011).

needed to respond to fluctuations in production from the renewable resources to maximize the amount of renewable energy in the system.[2]

An important issue in renewable energy development has been the inability to rely on intermittent renewable sources, such as wind and solar, for base load power. It is not economical to ramp up or reduce production at large conventional base load power plants; so even if wind or solar plants are producing enough electricity to supply both peaking and some base load demand, it does not generally offset fossil fuel-based or nuclear base load energy generation. Small, agile hybrid energy systems are one way to allow energy production from intermittent renewable sources into the grid more reliably. To respond accordingly to peaks and dips in renewable energy production, hybrid systems are best implemented on a small scale because small generators are more flexible. These agile systems can, when possible, be interconnected into the central grid system and function as small power plants.

Opportunities in Asia and the Pacific

- **Hybrid energy systems are particularly well suited for use in remote locations.** Hybrid systems can serve standalone mini-grids, thus avoiding costly transmission costs. The increased capability of integrating renewable energy production into the electricity mix reduces the costs of transporting fuel to remote areas.

- **Applicable for combined heat and power and district heating:** As technology systems that can be used for distributed generation, isolated grids or on-site application, hybrid energy systems are generally well suited for combined heat and power production or district heating.[3]

Strengths in using a hybrid system

- Hybrid systems can reduce reliance on fossil fuels and increase the share of renewable energy resources, including intermittent ones, thus increasing the eco-efficiency of energy production and energy security.
- Hybrid systems can reduce energy costs in the long run by offsetting fossil fuel use with renewable production.
- Setting up isolated grids can help provide modern energy access to remote areas and avoid the cost of expensive transmission and distribution lines from the central grid. Particularly in poor areas using diesel gensets, for which fuel price fluctuations can mean no electricity for a period of time, hybrid systems can help provide more reliable modern energy access.

Challenges to using a hybrid energy system

Financial

- The multiple components required to form a hybrid system generally make them expensive to build.[4]

Technical

- There is no single optimal hybrid energy system configuration. Rather, optimizing is based on the availability of renewable and non-renewable resources, on site-specific energy infrastructure, production costs and incentive policies. Planning a hybrid system thus necessitates an adequate study period for each proposed project site.

[2] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).

[3] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).

[4] J. F. Manwell, *"Hybrid energy systems" Encyclopedia of Energy* (2004), vol. 3, pp. 215-226. Available from http://resume.marcbrands.com/classfolder/45-859/https@blackboard.andrew.cmu.edu/courses/1/s04-45859/content/_185100_1/hybrid_systems_review.pdf (accessed 13 October 2011).

- Because many hybrid systems rely on the flexibility of small conventional power production facilities that can be dispatched as needed and/or on small storage devices to deal with intermittent renewable energy sources, these systems have limited scalability with the currently available technologies.
- Not all energy production and storage technologies that are potential hybrid system components are fully developed. It is risky to invest in long-term, expensive infrastructure that may improve significantly in the medium term.
- Implementing hybrid energy systems can create market opportunities for the deployment of energy technologies that are not yet mature.[5] If a particular technology, such as a new type of fuel cell, is not yet efficient or reliable enough to produce electricity in a stand-alone system, it may fit well as an additional component to a hybrid system in which other components can cover possible bumps in the production process.

Institutional

- Transmission interests and large electric utility interests may rely on political clout or financial assets to try to limit the expansion of hybrid energy systems development because they encourage more decentralized energy production.

Implementing strategies

Provide a net metering option in which a transmission grid encourages the development of hybrid energy systems, particularly in commercial applications: Net metering is a major financial incentive for small power producers because they can sell excess generation from renewable energy sources back to the grid at a retail – rather than wholesale – rate. Net metering requires advanced meters that communicate in real time. The production and use of smart meters is growing in China, and several ASEAN countries are beginning to follow suit. Although widespread use is a long-term vision, using smart meters with hybrid projects may provide a useful learning experience for utilities and power producers.

Introduce a feed-in tariff: Such an incentive can encourage the maximizing of renewable energy production in hybrid systems. The higher rate paid by the feed-in tariff is paid out relative to kWh of renewable production.

Subsidize the capital costs or provide soft loans for hybrid power systems to expand their use: For example, in India there is an upfront capital subsidy of up to 200,000 rupees (US$3,800) or 80 per cent of the project cost (whichever is the lower) for hybrid power projects built by community groups and government bodies. For private companies and individuals, the subsidy is lower – up to 125,000 rupees (US$2,400) or 50 per cent of the project cost. The highest subsidy, up to 240,000 rupees (US$4,600) or 90 per cent of the project cost, is allotted for non-electrified islands to promote electrification.[6] The low cap encourages small-scale development.[7]

Mobilize funding: Governments can seek out funding from the Clean Development. Mechanism under the Kyoto Protocol, rural development banks and other development organizations to upgrade diesel genset systems to hybrid systems or build new hybrid systems to provide modern energy access to rural areas.

Example

Koh Tao (island) in southern Thailand: the Provincial Electricity Authority (PEA) installed a hybrid wind-diesel energy system to increase power capacity and reliability and to reduce the long-term costs. The PEA had previously relied on a diesel system that cost 6.5 million baht (US$200,000) in losses per year due to high fuel and fuel

[5] Gary D. Burch, "Hybrid renewable energy systems", presented at the United States Department of Energy Natural Gas and Renewable Energy Workshops (Golden, CO, 21 August 2001). Available from www.netl.doe.gov/publications/proceedings/01/hybrids/Gary%20Burch%208.21.01.pdf (accessed 17 October 2011).

[6] India, *Wind-solar Hybrid Systems* (New Delhi, Department of Science and Technology, 2005). Available from www.technopreneur.net/technology/new-technologies/solar/wind-solar.htm (accessed 24 November 2011).

[7] Tata Energy Research Instiute and Agency for Environment and Energy Management, *Report on Utilisation of Hybrid Energy Services in Island and Rural Communities: Indian and European Scenario* (New Delhi and Paris, 2003). Available from http://insula.org/islandsonline/hybrid.pdf (accessed 24 November 2011).

transportation costs. Based on the wind resource, electricity infrastructure and geographic constraints, the PEA chose to install a 250kW wind turbine to reduce its heavy reliance on diesel.[8]

Further reading

"Design considerations for a sustainable hybrid energy system", by J.J. Ding and J. S. Buckeridge, in *IPENZ Transactions*, Vol. 27, No. 1/EMCh (2000). Available from www.ipenz.org.nz/ipenz/publications/transactions/Transactions2000/TransEMCh00/1ding1.pdf

[8] S. Saengsrithorn and P. Kitworawut, *The First Medium Wind/Diesel Pilot Project in Thailand* (Bangkok, World Energy, 2010). Available from www.worldenergy.org/documents/congresspapers/327.pdf (accessed 17 October 2011).