Hydropower in New Roles in Changed Context

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Abstract: This article focuses on how hydropower can facilitate to integrate more and more renewables in the grid. Doing so, we will have to create new hydropower products and market them. This will be possible if we have a vibrant power market allowing marketing of innovative hydropower products offering primary supply as well as other services in the grid.

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Traditionally hydroelectricity has been in the role of primary supply in the grid. Owing to its clean nature, it is a preferred source of primary supply in the grid compared to fossil fuel based sources. But in recent years many renewable sources have been developed and successfully connected to grid. Financial viability of grid connected renewable energy sources is increasing due to technological improvements.

As hydroelectric projects have long gestation period and are subject to geological and hydrological risks, preference of developers for investment is shifting from hydropower to other renewable sources. Hydropower projects have huge construction costs and large chunk of this cost comes from debt financing of banking and financial institutions. Availability of debt financing is main drive for hydropower projects but preference of debt financer's is also shifting from hydropower projects to renewable energy projects. This increasing preference of both developers and financers towards new renewable sources of energy compared to hydropower is certainly a serious challenge for hydropower. To cope with this challenge, new hydropower products with their unique attributes should be developed to establish hydropower in new role in the grid.

Intermittent nature is a deficiency of renewable sources that limits the extent to which they can be integrated in the grid. In this context, apart from its traditional role as source of primary supply in the grid, hydropower can play the role of facilitating the integration of renewables in higher proportion in the grid and go hand by hand with renewables. Hydropower can support the grid to integrate more and more renewables in following ways:

Frequency Regulation Service

Power output of renewable sources is very susceptible to factors of weather such as sunshine and wind velocity. Due to this impediment, quantum of power supply in the grid from renewable sources changes abruptly with the change in these weather factors resulting in real time supply fluctuations and ultimately frequency variations. These real time supply fluctuations and subsequent frequency variations in the grid pose a serious challenge for system operators to keep the system in balance i.e. control the system frequency. Similarly, real time demand fluctuations are very common in the grid but renewable sources, as already mentioned above, are poor in addressing them as they have very limited regulation. If renewable are major source in the portfolio of primary supply in the grid, then real time demand fluctuations shall remain unaddressed which may lead to very low or high frequency in the grid and ultimately the system failure. This means renewable sources are unable to address real time demand fluctuations in the grid. If renewables are major sources of primary supply in the grid then stability of grid will be at stake and it will always be under threat of collapse. In brief, renewables as source of primary supply in the grid offer zero or very limited real time frequency regulation to address real time demand variations. They are rather source of real time frequency variation due to their real time supply variation.

Owing to these deficiencies, unlimited integration of renewable sources in the grid is not possible. There are limitations to integrate the quantum of power generated from renewables in the grid. Generally 10% of the peak supply is taken as upper limit of renewables to be integrated in the grid. If we want to use renewables as major source of primary supply in the grid i.e. integrate higher proportion of renewable sources, then we need some spinning source in the grid that can be instantly regulated to offset effectively the real time frequency variations caused by demand or supply fluctuations. In fact quantum of renewables that can be integrated in the grid is contingent to available capacity of this special source in the grid that can provide real time frequency regulation. Hydropower is the best source for this purpose.

So apart from "Primary Supply" as traditional hydropower product, we can develop and market new hydropower product as "Real Time Frequency Regulation Service". Ramp rate of governors of these hydropower plants offering "Real Time Frequency Regulation Service" can be set as instructed by system operators depending upon the system requirement. This product can be priced at premium.

Voltage Regulation or Reactive Power Supply Service

Not all but few promising renewable sources like photovoltaic solar power do not supply reactive power for voltage balance in the grid. Non availability or limited availability of voltage regulation is a threat for stability of the system. It may lead to system collapse. If we wish to integrate more and more solar photovoltaic power in the system, we need to have some other spinning source that can supply required quantum of reactive power on behalf of renewable sources. Hydropower can offer this reactive power very effectively. So "Voltage Regulation Service or supply of reactive power" can also be a special hydropower product that can help in integrating more and more renewable sources in the grid.

Traditionally hydropower plants have been providing a single product as combination of primary supply, frequency regulation and voltage regulation. But in the changed context, these three services may be segregated in three different products and marketed separately as premium products. This opportunity is there due to deficiency of renewable sources to offer these services.

Loss Compensation Service

Bulk consumers purchase power either through bilateral power purchase agreement or from market. Purchase - Sale quantum as per agreement is delivered by generator at generator's point of connection and off taken by bulk consumer at off taker's point of connection. Transmission Company provides the wheeling of this power from generator to off taker. Should there be no losses in the transmission system, power quantum off taken by bulk consumer would be equal to delivered by generator. But due to transmission system losses, even if the generator delivers the power quantum as per agreement, power receivable at off taker's point will be less. For example if a cement factory "X" and generator "Y" sign a purchase sale agreement for 20 MW then generator "Y" will inject 20 MW at generator's point of connection and cement factory will off take 20 MW at its off take point. In this case the system will be unbalance by quantum equal to real time transmission losses, say 1.5 MW, from generator's delivery point to purchaser's off take point. Since this unbalance is resulted from losses in transmission system, transmission service provider has to take the responsibility of this unbalance. In this case, transmission service provider will purchase 1.5 MW from another generator in real time and inject in the system to keep the system in balance. In other words, transmission system provider will receive 20 MW from generator "Y" at generator's delivery point and provide 20 MW to bulk consumer at it's off take point but will purchase unbalance 1.5 MW due to real time transmission system losses from another generator and inject in the system. This loss compensation supply in real time cannot be assured by renewable, and hydropower is the best option to offer this unbalance supply service. So hydropower can develop and market another typical product as "Loss Compensation Supply" and transmission service provider will be the purchaser of this product.

Peak Demand Supply Service

Power systems do not have a consistent load throughout the day. Depending on various system specific factors, every power system has daily maximum demand during certain hours of the day and usually it is during evening hours. Due to this diversity of demand, system is exposed to sharp and substantial demand rise during peak hours which rise is different than minor demand fluctuations. Most renewable sources connected to grid cannot regulate their generation output according to system demand in real time. This means if more and more renewable are to be integrated in the grid, and then we need some other source that not only can address the minor frequency variations due to real time load or supply fluctuations but also substantial shoot in the demand during peak hours.

Hydropower is the best option to serve this peak demand. We can develop another hydropower product "Peak Supply" and market it at premium price. This indicates that if we develop hydropower projects as PROR (with peaking pond) or Storage then we can have both products i.e. Primary Supply and Peak Supply from same plant.

Energy Storage Service

Generation output of many renewables is contingent to weather factors but demand does not change in the same direction and same quantum. If we integrate more and more renewables in the grid then during certain hours of the day when weather conditions are favorable for generation, the generation may surpass the demand. Ultimately, we will have to switch off the generation. But if we have some means to store this available surplus generation as capital stock of energy we can market it later when there is demand in the system. Grid connected batteries have been developed to be charged by this surplus generation and supply in the system when so required. But batteries developed so far can only address short term fluctuation in the system. Hydropower units can quickly regulate their generation and are most suitable to offer this storage service. They can offer daily, weekly or seasonal storage service. So by developing PROR, Seasonal Storage or Pumped Storage Hydropower Projects; we can offer "Energy Storage Service" as another product in the hydro product line. Hydropower projects with this storage facility can sign "Energy Storage Service Agreement" with Run - of- River (ROR) hydro or renewable generators. Alternatively this agreement can be signed with system operator also.

Black Start Service

System restoration after collapse is a difficult and time taking process. One of the reliable generating unit has

to be started first and should supply to some load. Then step by step other units of system are synchronized and load is gradually increased corresponding to these synchronized units. Voltage and frequency balance at this stage is very critical. Starting of this first unit is called 'Black Start' and this generating unit has to be robust to absorb voltage frequency fluctuations. Renewable sources cannot offer this flexibility. Hydro generating units are best for this service. This "Black Start Service" product can be marketed at premium price.

To make this concept of multiple hydropower products to facilitate the grid for integration of more and more renewables a reality, liberalization of power market in the country in form of a power market where complimentary benefits of different types of sources are marketable with clear market rules is the main drive. For this to happen, role of an effective Sector Planner and Sector Regulator is very important. A forward looking sector planner can give the vision and regulator can accelerate this process.

Besides this, traditionally hydro-potential and its development has been a subject of state hegemony. Above innovative hydropower products may have a potential trans-boundary market. So a shift from state hegemony to development and marketing of water resource for coordinated and cooperative use across the tran-sboundaries is also need of time.

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