Policy Impact on Generation of Renewable Energy

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Abstract. The energy consumption is increasing throughout the world. The renewable energy is potential answer to meet the increasing demand. Fossil fuel are diminishing with fast pace and greenhouse gas emission potential. So, the world is promoting renewable energy generation. In this work, government policy impact is assessed for renewable energy promotion. The 4% subsidy on solar, increases approximately 1200% of solar energy generation in 23 years’ term and 4% subsidy on wind, increases 69% in wind power generation. The case, on per tone CO₂ emission by fossil fuel-based plant is also reducing the use of non-renewable power energy uses.

1. Introduction:
The increasing demand of energy is increasing the search of new environmental friendly energy sources. Traditionally, generation of electrical energy by fossil fuels have air pollution and will last forever [1-2]. To subside this, now countries are promoting renewable energy generation [3]. Currently, the generation share of non-renewable is approximately 85% of total energy demand of world [4]. This current demand of energy is increasing by 1.7% per year. So, to cope up this energy demand renewable energy is a non-exhaustive, easily available and environmental friendly option [5]. In current prospect renewable energy is not so cost-effective solution as non-renewable. The world climate agencies and countries are focusing and countering this issue by providing different type of subsidy to promote renewable energy sources. In this study, promotion mechanism for renewable energy is analysed. And it aims to investigate a clear production picture of RE and non-RE, if subsidy is provided for RE production. In next section methodology is described which is of e4st, that is used for analysis. The analysis is shown with the help of two cases of different subsidy. In last section, conclusion is made with help of outcomes of two cases.

Table.1. Renewable Energy Policy of Different Governments

| Country | Quality Driven | Quantity Driven |
|---------|----------------|-----------------|
| EU [6]  | 20% of total electricity will come from renewable energy sources by 2020. | Green Certificate, tariff support |
| USA [7] | 20% of total electricity will come from renewable energy sources by 2020. | Financial Incentive |
| UK [8]  | Quota and renewable obligation | Tradable green Certificate |

2. Methodology and Input Data:
In this work e4st is used to analyses the financial subsidy effect on long term renewable energy generation. It optimizes the benefit to the consumer subject network and load constraint [9].

\[
\max \left( \sum_n CB - \sum_n O&M - \sum_n PollutionCost - \sum_n AnnualInvestment \right)
\] (1)

In equation 1, CB is consumer benefit which has to be maximized minus operation and maintenance cost of the plant, pollution emission adjustment and sum of different annual investments.
The capital cost of solar is fixed to 799 $ per MW and in initial estimate 0% subsidy and in second case 4% subsidy is accounted. The cost of CO2 emission by Non-renewable energy power plant is taken as 4$ per ton in first case and 8$ per ton in second case, similarly the capital cost of wind is taken as 1178$ per MW in first and second estimate but subsidy is increased to be 4% from 0% in second estimate.

3. Result and Discussion:
In this section, feasibility is analysed with the help of two cases. These cases have two different subsidy percentages and two different penalties of CO2 emission.

Case-I
In case-1 analysis, solar power plant and wind plant cost is fixed and subsidy is not provided at all to these RE plants, shown in fig.1.A and fig.1. B. According to these input variables the generation patterns of RE and non-RE plants are shown in fig.2.A and fig.2. B. With the above analysis and outcome of e4st fast predictor it is clear that RE generation is increasing and non-RE generation is decreasing. In RE solar increase percentage is more than wind based plant. However, nuclear energy generation is increasing with slow rate, which shows it has the capability to compensate the reliability issue associated with renewable energy generation. The net benefit s also increasing with proposed combination, shown in fig.3.
Fig. 3. Net Benefits at 0%

Table 2. Generation of power with 0% subsidy

| Plant           | 2012      | 2025      | 2035      |
|-----------------|-----------|-----------|-----------|
| Hydro Plant     | 611161766 | 611462336 | 611490300 |
| Wind Plant      | 99010466  | 115397875 | 131551294 |
| Solar plant     | 2384489   | 12630403  | 1221667492|
| Coal Plant      | 1541887058| 1237762849| 1221667492|
| Gas Plant       | 1530809798| 2100151294| 1611580089|
| Nuclear Plant   | 846698984 | 846695609 | 846705798 |

Case-2
In case-2, the subsidy ratio of solar and wind is increased from 0% to 4%. The carbon tax imposed on non-RE plants is also increased from 4 dollars per ton to 8 dollars per ton, shown in fig. 4.A and fig. 4.B.

Fig. 4. A. Input parameters of Solar
Fig. 4. B. Input parameters of Wind
The outcome of above analysis shows that the rate of increase in RE generation is higher with subsidy support. The hydro plant is consistent performance and solar is increasing more rapidly. The net benefit is also large with compared to no support, shown in fig.6.

The following table shows the generation of power with 4% subsidy for different plants:

| Plant       | 2012       | 2025       | 2035       |
|-------------|------------|------------|------------|
| Hydro Plant | 611161766  | 611472596  | 611553135  |
| Wind Plant  | 99010466   | 150285523  | 168003109  |
| Solar Plant | 2384489    | 26806629   | 301964791  |
| Coal Plant  | 1541887058 | 1079031402 | 1057803053 |
| Gas Plant   | 1530809798 | 2064028979 | 1574119721 |
| Nuclear Plant | 846698984  | 846724225  | 846732872  |
4. Conclusion

This study shows the long term impact of promotion of RE generating systems. The subsidy support to RE is increasing the generation capacity substantially in the analysis period, which is shown in table 2 and 3. Moreover, the penalty on carbon emission also reducing the use of non-RE generation, specifically coal based plants. The capacity increase is more in solar plant than in wind power generation. However, total phase out of non-RE is not cost effective and reliable with above subsidy consideration and it requires more support from government and stakeholders. The nuclear power plant is increasing generation instead of support to RE which means it can be used for improving reliability of the system and it also has less negative environmental impact than coal or gas based plant.

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