Chapter 1
Review of Policies Toward the Acceleration of the Adoption of Renewable Energy Technologies

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Abstract This chapter reviews energy policy supporting diffusion of renewable energy (RE) and describes different types of available RE. The increased level of carbon dioxide is the main cause of the "Global Warming Effect." One suggested solution to global warming is to replace the current energy technologies with alternatives that have similar or even better performance, but do not emit greenhouse gases (GHGs). Beside environmental concerns, energy availability concerns and political pressure have prompted governments to look for alternative energy resources that can minimize the undesirable effects for current energy systems. Shifting away from the conventional fuel resources and increasing the percentage of generated electricity from renewable resources is an opportunity to guarantee lower (CO_2) emissions and to create better economic opportunities for the United States. RE resources offer a good alternative for the current fossil fuel system with its minimal impact on the environment and unlimited availability. Even with the fact that a diversity of renewable energy resources available in the United States and the development of the technologies themselves are more mature, the use of such resources is still very limited in the United States, but as the fossil fuel system is deteriorating with price increase and supply scarcity the transition to a new era of renewable energy is inevitable (Energy Policy 31:353–367, 2003). Policy can play an important role in promoting the penetration of renewable energies (Energy Policy 39:4726–4741, 2011). This chapter discusses the available policies that can promote RE adoption and deployment as well as the available technologies and literature assessing that adoption.

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With the foreseeable need for renewable energy (RE) adoption in the power generation sector, many literatures have emerged discussing the need for wide-ranging policy regime to facilitate this adoption. Three main directions were found in the literature: (1) literature explored the main players in policy formulation and their roles (government, private investors, and public), (2) literature explaining the characteristics and impact of different energy policies on one or more RE, (3) studies that demonstrated barriers and benefits of RE technology adoption and analyzed policy targets to maximize deployment and development.

For RE policy to be successful, understanding the economic, legal, and institutional aspects for a technology is needed for increasing diffusion in power sector. Norberg-Bohm discussed an in-depth history of technological development for four electric power technologies: wind turbines, solar photovoltaic, gas turbines, and atmospheric fluidized bed combustion [3]. The paper explained the role of government in technology commercialization and what policies were implemented in the United States (supply-push and demand-pull approaches). Federal policies mainly take the form of R&D funding or financial incentives. Kobos et al. argued that without institutional support, emerging energy technologies are limited by their costs from adoption and reaching consumer market [4]. Their analysis explored the relationship between RD investments, energy cost reduction, and market penetration. The methodology used here is to combine two theoretical frameworks: the estimate of energy cost as a function of cumulative installed capacity (a learning by doing factor) and cumulative RD&D expenditures (a learning by searching factor). The study concluded that institutional policy instruments play an important role for renewable energy technologies to reach sufficient cost reductions and further market adoption [4]. Anderson provided a review of policies and noted that investment followed by R&D activities and environmental policies are key factors for RE development [5]. Jaffe et al. provided a background of environmental policy in the United States and emphasized on a need for a public policy that encourage emission reductions and environmental aspects of a technology [6].

The European Union has emerged in the literature as a leader in RE adoption and formulating energy policy with a target of promoting RE resources in its member countries through establishing an aggressive energy policy [7, 8]. Different studies presented a comparison between two policy mechanisms that are under consideration in the EU to promote RE adoption: tradable green certificates (TGC) and feed-in tariffs (FITs). It was found that the TGC system is likely to be less effective and less efficient than the FIT and that FIT deliver larger and faster penetration of RE than TGC, at lower cost [7, 9, 10]. Söderholm and Pettersson presented an analysis for the effect of policy system in Sweden on increasing offshore wind power deployment [11]. Toke also analyzed offshore wind energy in the UK and the policy effectiveness [12]. In both papers, it was found that there is a kind of policy for promoting such technology as the financial incentives but the public support and acceptance for the slightly increased electricity price is more likely to help achieve targeted capacity goals. This supported the findings in Zografakis et al. of the high attention policy makers should give in planning and implementing renewable energy projects for how much more customers are willing to pay for renewable energy more than for fossil fuel energy [13]. For a summary of renewable energy policies and methods used for assessment, please refer to Table 1.1.

Table 1.1 Summary of energy policy and corresponding literature

Policy	Literature	Methodology
R&D funding	[14]	Technology S-curves to analyze RE performance and R&D investments
	[4]	Experience curves for energy cost as a function of cumulative capacity and R&D investments
	[15]	Comparison between R&D funding between different countries and its effect on wind adoption
	[16]	Patent analysis to investigate the effect of new knowledge on energy investment decisions
Tax credits, grants, and incentives	[17]	Empirical study
	[18]	Case study
	[17]	Quantitative cash flow analysis
Cap and trade	[19]	Case study
	[20]	Scenario analysis
RPS	[18, 21]	Case study
	[22]	Empirical research with incentives as indicator of magnitude and capacity
	[23]	Fixed-effect model to evaluate the effectiveness of RPS and percentage of RE generation
	[24]	Case study
	[25]	Scenario analysis, numerical simulation
	[26]	Linear regression
REC	[27]	Comparison between RPS requirement of different states and the effect of integrating REC
	[24]	Case study
Feed in tariff	[8]	Comparative study for different energy policies adopted in European countries
	[28]	Case study
	[29]	Case study for different model to structure FIT
Mandatory green power option	[30]	Fixed-effect model
	[26]	Linear regression

Other studies have analyzed the status of diffusion of renewable energies and its implications. Cantono and Silverberg developed a network model of new technology diffusion to analyze the relationship between the diffusion of a new technology, learning economies, and financial support [31]. Rao and Kishore took another path where they utilized diffusion models to understand the development of RET and the barriers affecting that adoption [32]. To shift to a new energy system involves changes of the whole ecosystem nature regarding structural, organizational, economic, and social entities. Tsoutsos and Stamboulis argued that the basic of a successful renewable energy policy is to consider that renewable technologies are a different system from conventional resources and have different barriers and stimulants [33]. With this recognition of system complexity, there is a need for a tool that can integrate a large number of variables in the energy policy system and have results and analysis presented in a usable manner. Bassi and Shilling presented a computer simulation model (Threshold 21) as a tool for comprehensive national policy planning that can analyze the long-term implications of policies and strategies including their positive and negative impacts [34]. Running the simulation model for different scenarios for multiple elements in the United States (society, economy, environment) revealed that the direction in policy making should be directed to enforcing new government regulations to manage energy consumption, focus on developing new clean technologies, and improve energy efficiency and conservation while the current policy trends in the United States will only increase the use of foreign fuels which will lead to more price fluctuations.

1.1 Renewable Energy Policy in the United States

In spite of the federal government efforts in pursuing solutions to deploy RE through several policy regimes [35], it looks like those efforts lack coordination between states themselves and a comprehensive long-term planning which led state and local governments to step in with several policy approaches and distinguish themselves as renewable energy policy establishers [23, 36]. Surveying the literature revealed three main directions or focus for policy intended to increase RE adoption:

- Mandated regulations:
  Those kinds of policies are mandatory regulations that power generators or other stakeholders like customers should comply with. This direction of policies is targeted to maintain a certain level of renewable energy sources in the power generation energy mix or keep GHG emissions under a certain value.
- Market-based policy:
  Renewable energies are supposed to establish themselves in an already mature fossil fuel market with low prices, resource availability, and already accessible technologies. These policies are designed to facilitate communication between generator and consumer as well as establish a competitive price for renewables.
- Financial based:
  Policies designed to overcome the financial obstacles facing renewable energies to increase development and deployment, both consumers and developers benefit from such policies.

1.1.1 Federal Policy

It is necessary to provide incentives for the development and diffusion of the renewable energy in different fields. The federal Energy Policy Act of 2005 set up a tax deduction for energy-efficient commercial buildings in the United States. A tax deduction is given to owners of new or existing buildings who install (1) interior lighting; (2) building envelope, or (3) heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost by 50 % or more [37]. This policy act had also impacted R&D efforts for different types of renewable energy which had increased the installed capacity of several resources [38].

- Financial incentives:
  Production Tax Credit (PTC) and Federal Investment Tax Credit (ITC) are federal policies in the form of financial incentives that provides an amount (cents/kWh) to private investors and investor-owned utilities that deploy RE resources in their production. PTC has been found that it had a great effect on wind energy deployment and development in the United States [2, 18, 26]. Under The American Recovery and Reinvestment Act of 2009 ("ARRA 2009") projects that are eligible to receive the PTC can instead choose the ITC, which is a credit of 30 % of the cost of development depending on the source of energy used [17]. There are other financial incentives in the form of loans and grants to fund projects and buy equipment. Clean Renewable Energy Bonds (CREBs) are another financial incentive that can finance renewable energy projects. Eligible technologies are generally the same as that used for the federal renewable energy PTC.

- Carbon tax or carbon cap and trade:
  This is a federal environmental policy that is designed to gradually reduce CO_2 and other GHG emissions in a cost-effective manner. Under this policy, a limited amount called "cap" is allocated on each large-scale generators for the emissions produced and issues permits as a share of that cap, the holders for these permits can trade them to other ammeters which create a market for green energy. The caps will become lower over time which leads to less and less GHG emissions until the desired reduction goal are met [39]. A cap and trade program has been proposed by the Obama administration but hasn't passed the congress yet. There are similar programs endorsed by the Clean Air Act of 1990 [40], which target other emissions and it had met their intended emission levels. Examples of these policies are nationwide Acid Rain Program and the regional NOx Budget Trading Program in the Northeast and the Clean Air Interstate Rule (CAIR).

1.1.2 State and Local Government Policy

Several states have adopted different energy policies to promote the adoption of RE [41]. Roach presented a survey of current energy policy in the United States and it noted that since each state is different, they should be allowed to tailor their specific policy according to their specific needs [19]. State government actions can take different forms like financial incentives, direct regulations, and regulatory changes. Menz and Vachon presented an empirical analysis on the effect of RE policy to determine which policy has more effect on wind energy capacity installed [26]. The paper analyzed the effect of different state policies, namely, renewable portfolio standards (RPS), fuel generation disclosure rules, mandatory green power options, and public benefits fund on wind power development. The results of this study showed that RPS is an effective policy for promoting RE deployment. Carley builds on Menz and Vachon 2006 efforts and tests directly the relation between RE generation percentage across states and state RPS and electricity-based RE policy incentives with an empirical investigation using casual effect models (fixed effects vector decomposition model, FEVD) [23]. In a report by National Renewable Energy Laboratory, the effect of various RPS and cap-and-trade policy options on the US. electricity sector was examined. The analysis uses the simulation model ReEDS to estimate the least-cost expansion of electricity generation capacity and examine the impact of an emissions cap as well as scenario analysis. The report also examines the effects of merging RPS policy with the emissions caps [20].

- Renewable portfolio standards (RPS):
  Renewable portfolio standard is a state policy that requires a predetermined percentage of the electricity produced or sold in a state to be from qualifying renewable energy resources. Twenty-nine states plus the District of Columbia have already established RPS [42] but the regulation is different from one state to another. Eight other states have set voluntary renewable goals where it only applies to private investors and it is nonbinding [43]. Electricity providers are given the chance to satisfy the RPS requirements by purchasing renewable energy credits (REC) from other qualifying producers. Kydes analyzed the impact of imposing a federal RPS of 20 % nonhydropower renewable generation levels on the US energy markets by 2020 [44]. The analysis was conducted by using the December 2001 version of the National Energy Modeling System (NEMS) of the Energy Information Administration (EIA) and the assumptions and results of the Annual Energy Outlook 2002 (AEO2002) reference case. The conclusion of the paper was that this policy seems to be effective in encouraging the adoption of renewable energy technologies. With this agreement on the benefits of RPS, surprisingly Sovacool and Cooper disagree. They argue that state RPS has several deficiencies and the transmission to a federal mandatory level would provide more clarity and unity in objectives and initiate a national commitment to RE generation [45].

- Financial incentives:
  State governments offer financial incentives to encourage the adoption of RE and their main target is to overcome the financial obstacles that make RE investment unattractive to investors. These financial incentives can have several types; it includes tax deductions and credits, subsidies (grants, loans, etc.).

- Feed in tariff:
  A FIT is an energy policy dedicated to support the development of new renewable power generation. Under this policy in the United States, generators are paid a cost-based price for the renewable electricity they produce where utilities are required to buy electricity from eligible renewable energy generators. Fifteen states and three other municipal utilities have considered FIT legislation [28].

- Green certificate market:
  This is a market based policy that is designed to open markets for power generated from renewable resources. This policy defines an obligation from consumers to utilities to purchase a certain amount of electricity generated from renewable energy sources. This market assurance is an incentive to supply green certificates since they can increase their revenue [7, 10, 46].

- Mandatory green power:
  It is a state policy that obligates utilities to offer their customers the option to get their electricity from renewable resources. Kneifel estimated the effect of different state policies in all 50 states using state fixed-effect model. It was found from the analysis that RPS, funding, and green power option have a great impact on increasing RE capacity in each state [30].

1.2 Alternative Energy Technologies

Alternative energy is a general term that refers to any source of energy that is going to supplement or replace current energy sources. The use of this term has changed along the history where different types of energy resources had replaced others like coal replacing wood as a source for heat and energy. Alternative energy now refers to any source of energy that replaces the current fossil fuel system without having the consequences on the environment or energy security as fossil fuels do [47]. Different factors are considered when searching for sustainable alternative energy sources such as availability, cost, and environmental impact. The combustion of fossil fuels is accompanied by emissions of large quantities of carbon dioxide into the atmosphere which enhances the greenhouse effect and consequently global warming and climate change. There is a pressing need to develop a highly efficient energy deployment processes to substitute current energy sources and control the current CO_2 matter [48]. Alternative energies can be utilized to substitute fossil fuels in different capacities such as power generation or transportation. Although some new technologies are not renewable such as new energy efficiency technologies, they can still be considered alternatives as it minimizes the effects of fossils.

1.2.1 Energy Efficiency Technologies

Many different stakeholders can be involved in the evaluation and preparation of energy policy. Government can play a key role in formulating the policy for any new energy technology adoption and commercialization path [49]. Chai and Zhang explored the technological and policy issues in China that facilitates the adoption of a more sustainable energy system, energy efficiency technologies, and renewable energy technologies [50]. It was found that for the transition to a sustainable energy system additional actions can be done such as R&D support of new innovative sustainable energy technologies, improving manufacturing capacity of these energy technologies, and offering more economic incentives for research and development. On the other hand, Luiten et al. investigated and analyzed the effect of government intervention as R&D support for four different energy efficiency industrial processes and its innovation [51]. The analysis of four industrial processes revealed that although government support for R&D is an important policy in motivating energy efficiency technologies, the effect of this policy is dependent on the stakeholders in the industry itself. Noailly and Batrakova investigate the relation between technological innovation for energy efficiency technologies and energy policy in the Dutch building sector [52]. By developing a patent analysis method, the authors aimed to explain the innovation in energy efficiency technologies in buildings and presented a complete historical overview of the energy policy instruments in Netherlands as a case study. A review of the diverse Dutch policy initiatives shows that environmental policy has greater effect on adopting energy efficiency technologies rather than financial incentives.

1.2.2 Alternative Transportation Fuels

Although the transportation system in the United States is still highly dependent on petroleum, energy security and environmental issues have been pushing to consider alternative transportation fuels. Hydrogen is considered one of the possible "good fuels" to replace current transportation fuel system [53]. Alternative fuels can be ethanol, hydrogen, biodiesel, and others, see Fig. 1.1. Ethanol is still the most

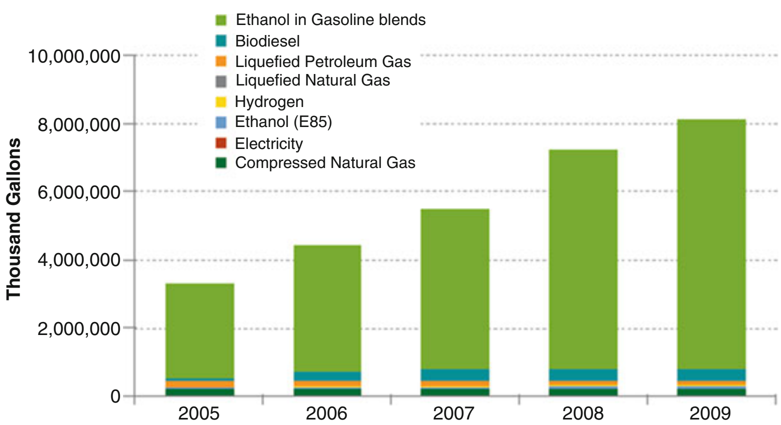

Fig. 1.1 Consumption of alternative fuel in the United States [54]

produced fuel in the United States. However, biodiesel production in the United States has seen an enormous increase in the last decade.

Meyer and Winebrake evaluated the diffusion of hydrogen technology in the automobile sector in the united States and analyzed barriers affecting this diffusion as well as related policy [55]. The analysis utilized system dynamic modeling and scenario analysis to evaluate the diffusion of hydrogen technology (vehicles and refueling) as complementary goods. Hydrogen refueling infrastructures are considered complementary goods, and complementary goods are goods that must be used together since they operate as a system (DVD players and DVDs). The results prevailed that both hydrogen vehicles and needed infrastructure should get attention by policy makers and given more incentives to achieve market penetration.

1.2.3 Renewable Energy

Even though wind and solar technologies have exhibited large growth rates [56], nonhydropower renewable in total (wind, solar, geothermal, biomass) still count for a small percentage of total US power consumption [57], (see Fig. 1.2 and Table 1.2).

There is a need for an energy system that helps to overcome barriers for RE adoption and guarantee the maximum benefits of such adoption [58]. Holmes and Papay analyzed the US energy system and noted that national targets of 10 % by 2020 and 20 % by 2035 of the US power supply to be from nonhydro renewable can be achieved given the coordination between policy regimes, technology development, and capital allocation [59]. Kajikawa et al. opted to understand the research structure of renewable energy in two studies [60, 61]. The first explored what emerging technologies are in the field of RE by using citation network analysis. Their

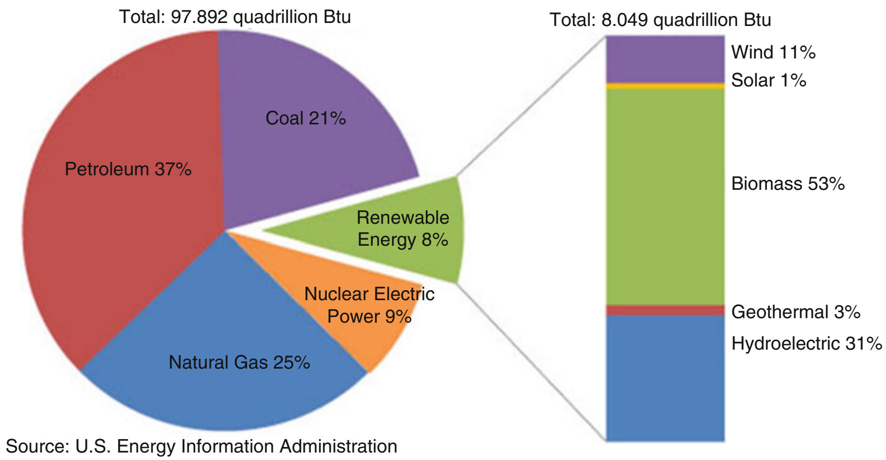

Fig. 1.2 Renewable energy consumption in the US energy supply, 2010 [56]

Table 1.2 Renewable energy sources

Energy	Description
Solar energy	Solar energy technology is a variety of technologies that have been developed to harness the solar energy from the sun and convert it to electricity or heat. It includes different technologies: concentrating solar power systems, photovoltaic systems, solar hot water, and others. Solar power can be used in either large-scale applications or small residential application
Wind energy	It is the technology to harness the power of wind by wind turbines. Wind turbines can be used as stand-alone applications for water pumping or as part of utility power grid to generate electricity. Wind energy is the fastest growing renewable energy technology worldwide
Hydroelectric	The technology to benefit from the running water power. It can be harnessed by building large dams on natural reservoirs and used mainly for electricity generation
Biomass	Biomass energy is the energy from plants and plant-derived materials. Wood is still the largest biomass energy resource today, but other sources of biomass can also be used: food crops, residues from agriculture or forestry, and industrial wastes. Biomass can be converted directly into liquid fuels (biofuels) or used to generate electricity
Geothermal	Geothermal energy is taking advantage of heat from the earth. This heat can be drawn from several sources: hot water or steam reservoirs deep in the earth. It can be used on both large and small scales, either to drive generators and produce electricity or to provide heating and cooling in homes and other buildings
Ocean	The oceans cover over 75 % of our planet. The ocean energy can be harnessed from the tidal waves and ocean temperature difference to generate electricity

analysis found out that the fuel cell and solar energy are rapidly growing domains in energy research. The second paper looked more in details at the biomass as a sustainable and renewable energy growing rapidly. In this paper, they performed a citation network analysis of scientific publications to unfold the current structure of biomass research. Their work revealed the taxonomic structure of biomass research especially focusing on biofuel and bio-energy research. Shen et al. examined how different policy goals (energy, environmental, economic) is satisfied by renewable energy resources in Taiwan. The analysis utilized AHP model and scenario analysis and concluded that hydropower, wind, and solar energy are the three technologies that could meet the three policy goals [62]. On the other hand, Shrimali and Kniefel analyzed the US state policy to determine which policy had led to increasing installed renewable energy capacity [2]. The analysis utilized state fixed-effects model and case studies for four types of renewables (wind, biomass, geothermal, and solar). For a summary of literature studying alternative energy technologies adoption and the methods utilized to assess this adoption, please refer to Table 1.3.

- Wind energy:
  China is the world leader in cumulative installed wind capacity followed by the United States. Wind energy is the fastest growing renewable energy in the United States with Texas leading the states in wind installation in 2010 [54].

Table 1.3 Summary of technologies studied and methodologies used for evaluating their adoption

Technology	Literature	Methodology
Alternative fuels	[55]	System dynamic
	[67]	Case study
Energy efficiency technologies	[52]	Patent analysis
	[51]	Case studies
	[69]	AHP/DEA
Wind (offshore, wind farms)	[70]	MCDM
	[15]	Empirical study as a comparison between wind installed capacity in United States, Japan, and Europe in terms of R&D funding and policy measure
	[71, 18]	Case study
	[26]	Linear regression
	[72]	Bass diffusion model installed capacity
	[73]	Case study
Solar (PV, CTP)	[74]	Experience curves
	[75–77]	MCDM
	[29]	Case study, levelized cost method
	[78]	Bass diffusion model
Other renewables (biomass, geothermal)	[67, 79]	
	[80]	Case study

Bird et al. analyzed several drivers and policies that contribute to wind energy development in the United States and noted that it is not feasible to determine one single driver for wind power development but several drivers function as a package and influence one another's effectiveness such as renewable portfolio standard in combination with financial incentives as well as developing the market for green power [18]. Although considerable investments are necessary for initial stages of RE technologies used in power generation, wind turbines are already economically competitive under favorable conditions, and wind power subsidies have resulted in a rapid growth in the number of wind turbines installed. Niji discussed the possibility for cost reductions in renewable energy technologies on the long run. Experience curves were utilized to analyze the prospects for diffusion and adoption of renewable energy technologies, with more stress on wind turbines and photovoltaic (PV) modules [63]. Loiter and Norberg-Bohm also presented a study on the development of wind power in the United States [64]. The primary conclusion is that demand-side policies are needed to encourage diffusion of wind energy and the innovation in the technology.

- Solar energy:
  Solar energy utilization for electricity generation has grown consistently by about 20 % yearly over the past 20 years. This increase has happened as a result of manufacturing technology improvements, increasing efficiency of solar modules, and economies of scale which lead to decrease in cost. European countries and Japan that have more compelling solar policies lead the world in solar PV

deployment. In the same way, the states with more solar incentives have more cumulative and annual capacity installations in 2010 (California, New Jersey, Colorado, Arizona, and Nevada) [54].

Sawyer had examined the characteristics of the first homeowners who installed solar energy systems and integrated the information in a diffusion model to anticipate future solar market penetration patterns [65]. Sawyer looked at their socioeconomic characteristics, purchase motivations, and satisfaction levels and noticed that these individuals conform to the "early adopter" type identified in innovation diffusion research and not the "innovator" type that would be expected at this early stage of commercialization. In conclusion, he suggested that rapid market penetration is possible if the high capital costs characteristic of solar energy systems are effectively addressed.

- Hydropower:
  Hydropower remains the largest and oldest source of renewable energies. Although all the states utilize hydropower for power generation, the Pacific Northwest accounts for about 60 % of this production [54].

- Geothermal:
  Although the United States is a world leader in installed geothermal electricity capacity, this capacity has almost remained constant for the last decade. Geothermal is distinct from wind and solar that it has no intermittency and can provide reliable and constant power as well as direct heat [54].

- Biomass:
  Biomass energy is the energy from plants and plant-derived materials mainly agricultural residues. Biomass can be used to generate power or converted directly into liquid fuels (biofuels) for transportation. Biopower generation currently is 53 % of all renewable energy consumed in the United States [54].

  Biofuels use is of showing interest in different usage for its diversity and economy. Hoekman analyzed policy issues and adoption drivers for biofuels in the United States, describes usage trends, and emphasized on the role of R&D efforts to promote development of biofuel technologies [66]. Charles et al. addressed the issue of adopting renewable energy sources from a comprehensive public policy viewpoint [23]. The article explained the driving forces of current biofuel promotion policies, environmental and socioeconomic benefits, and problems and policy implications. Consequently, the authors concluded that the different policy instruments currently used or proposed by governments in developed nations to promote biofuels appear to be doubtful and open to discussion and debate [67].

- Ocean:
  Despite the huge potential available in ocean energy [68], this technology had not matured yet and not many projects are deployed worldwide. The interest of this energy had begun to grow recently in the United States with many prototype projects in testing stage (Table 1.3).

1.3 Conclusions

This chapter explored studies of renewable energy policy. Although there is an increasing number of literature exploring renewable energy policies [2, 22, 23, 26], the link between degree of adoption of renewable energies in the power generation sector and relative effectiveness of these policies is not yet well established. Many of the present research involves case studies that explain drivers and enablers for RE adoption [1].

Renewable energy technologies are becoming more and more important portion of the electricity supply mix, but they still face some challenges involving the large-scale deployment and commercialization. Economic consideration, availability of resources and their intermittent nature, social effects, and technology maturity impose a pressure on policy makers, scientists, and private investor to outline the way for a renewable future. Deploying renewable electricity and making it available on a scale that would make a major contribution to US electricity generation would require overcoming several obstacles like the need for huge investment and investors, development of technologies to be cost competitive, and human resources. Even with the federal government efforts and state regulations and mandates to encourage the adoption of renewable energies, this will only be successful with the help of private sector investment and support of innovation [19, 73]. The Office and Technology Assessment noted in the report (renewing our energy future) that energy policy had focused in the beginning at commercialization and operation of renewable with public support, but lately it had focused more on tax and subsidies policy that opened the way for more private investors [81].

RE adoption has so far been supported by environmental and socioeconomic dynamics and political systems. As seen from the literature, wind, solar, and biomass energy are now more deployed into the energy portfolio. However, most RE technologies (except wind and hydropower) are still at a very early stage of the diffusion. This delay of diffusion can be referred to the still undeveloped markets and ineffective policies. There is an imperative need to find a way that RE can penetrate the market in an already established energy market with cheap, available, and already mature fuel market. The ability to overcome market barriers and integrate renewable power in this market is a key factor to successful deployment of renewable electricity.

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