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Legal system for the development of marine renewable energy in the USA: a thorough analysis

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Abstract
Energy has gained great attention and extensive demand as an important element of the development of human society over the globe. As the representative of the traditional energy use, coal and oil have made a significant contribution to the economic take-off. However, their negative effects are becoming increasingly obvious simultaneously. On the one hand, the world is facing severe energy depletion crisis as the energy consumption increases. Eventually, the development and use of energy at large lead to a deteriorating environment. Facing these dual effects, States have begun to attach importance to the exploitation of renewable energy. Marine renewable energy (hereinafter MRE) has become the gateway to energy revolution based on its particular advantages. This paper pays attention to the American institutional framework and legal system for the development of MRE, along with its advantages, prerequisites, opportunities, and barriers, followed by various pertinent recommendations, as the U.S. is the leading country in this field. It is concluded that the U.S. has a comprehensive legal system for the development of MRE. However, it has to timely intersect with the opportunities and barriers in the light of the administrative or legal framework and enhance its institutional structure for the successful implementation as well as to be competitive for the attainment of required goals.

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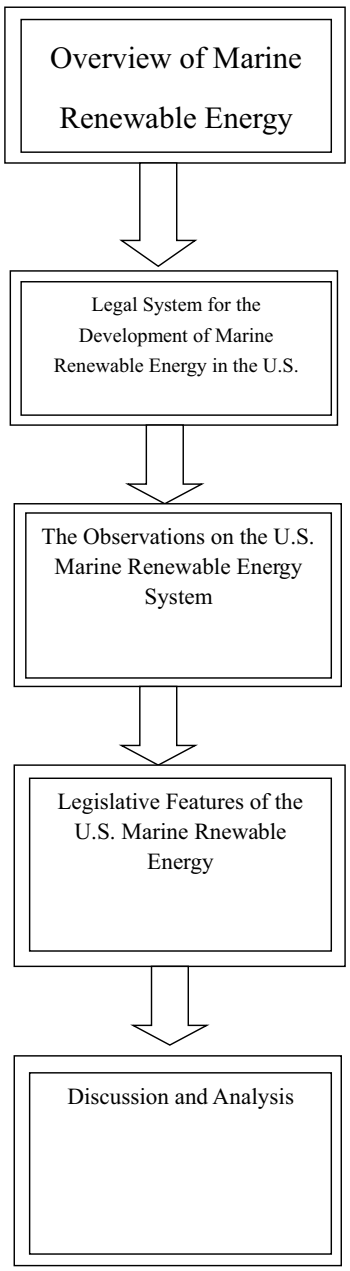
Graphic abstract



Keywords Marine renewable energy · U.S. energy act · Tax benefits · Financial subsidy

Introduction

The historic oil crisis in the 1970s and the increasingly serious environmental disaster begin to prompt States to take the energy issues on a serious note (Jackson 2018). It has become a universal demand of the world to seek renewable and clean energy. The salient characteristics of marine renewable energy (hereinafter MRE) being renewable and non-polluting have made it the centre of attraction for national research and development. Within this context, the U.S. owns not only advanced technology in this field but a complete legal system and a standard operation mode (Lange et al. 2018).

There are multiple reasons for choosing the U.S. as a subject matter in this study, e.g. first, substantial work in pilot testing to implement the energy resources for generating

potential electricity is underway. Secondly, several legal and policy windows are opening, and thirdly, a range of driving progress-actors are underway ambitious development in this domain at pilot scale and also being considered to be an important facilitator of blue and green energy (U.S. EIA 2016). Leaving behind the solar and geothermal energy, onshore wind and tidal energy sources have become the imperative innovative renewable energy technology, especially in the U.S. Therefore, offshore wind or marine renewable have been a topic of much debate and even the point of controversy in the coastal zone (Petrova 2013, 2014).

There is no doubt that global energy demand has increased significantly recently and is expected to increase by 56% between 2010 and 2040 (Abdmouleh et al. 2015a, b). In the meantime, the energy market faces many other challenges, such as water scarcity, economic and urbanisation growth, lack of energy security, population growth, and limiting fossil fuel reserves. To bridge this future gap between energy demand and supply and to take into account the risks posed by global climate change due to greenhouse gas emissions and other pollutants caused by excessive combustion of fossil fuels, a lot of attention was concerned with to energy efficiency measures by utilising the renewable energy sources. This is among the main reasons that the U.S. has considered MRE as a huge opportunity to build a green global economy, which may eventually turn into a circular economy, by investing more in the MRE sector, and encouraging the private sector to provide the full support in strengthening of the MRE sector of the country.

This paper discusses the system structure and operational mode of the American legal system in the field of MRE that could be considered as the role model for rest of the world. The main research questions of this study are the followings: what is the American model for the development of MRE? What are the shortcomings? How to incorporate the American model to improve energy legislation for sustainable development? This paper aims to explore the legal system for the development of MRE in the U.S. It has been observed in the study that the U.S. model could provide a systematic template for the development and utilisation of MRE. The study provides an institutional framework, prerequisites for the successful implementations, policy implication, opportunities, barriers, and various legal or administrative recommendations for the formation of relevant laws and further development in the MRE sector.

Overview of marine renewable energy

Definition of MRE

As to the meaning of renewable energy, the earliest formation of its recognition by the international community was at the United Nations Conference on New and Renewable Sources of Energy in 1981 (Biswas 1981). For the first time, the term 'renewable energy' has a widely accepted definition. That is based on new technologies and materials to modernise the development and consumption of renewable energy to replace traditional fossil fuels, which are limited resources and polluting the environment. Limited to the development of science and technology at that time, the scope of the new renewable energy defined by the conference includes wind energy, geothermal energy, solar energy, wave energy, tidal energy, etc. Professor Mirjan R. Damaska commented over the U.S. legal system regarding renewable energy, and stated that it is 'a coordinated model of multiple authorities' which address the same issue (Damaska 1975, 1991). It is also worth mentioning here that to accomplish the goals of renewable energy under the shadow of Article 2 of the Kyoto Protocol, which elaborates that each party should ensure the implementation of the pertinent measures, e.g. to bring reforms in relevant sectors for reducing GHGs, to diminish methane emissions in the waste management sector, conduct research on environmentally friendly technologies as well as in renewable energy sources (hereinafter RES), share information and encourage awareness in renewables, to improve overall energy efficiency, etc. (Teleuyev et al. 2017).

Tidal energy is generated by seawater fluctuation and the flow of tidal water, which is due to sea-level cyclical movements caused by periodic changes in the Earth–Moon gravity (Sun 2011). Tidal current energy is largely generated by the regular flow of seawater, which is caused by relatively stable year-round ocean currents and tidal phenomenon. Wave energy is generated by the waves on the surface of the ocean, which is a form of kinetic energy and potential energy generated by the wind. Thermal energy is a form of heat energy, which is the temperature variance between deep seawater and surface seawater. The temperature of surface seawater in low latitudes is higher; thus, there exists a temperature difference between deep seawater and surface seawater, and this temperature difference also stores energy.

Advantages of MRE

From a macro perspective, marine energy, existing in various forms, is the tremendous energy generated by the movement of seawater, taking it as a carrier. The ocean receives, stores and releases marine energy through a variety of physical processes. Compared with other forms of traditional energy, MRE has unparalleled advantages. Firstly, in terms of the process of generating and releasing energy by the ocean, marine energy comes from solar radiation and the gravitation between celestial bodies. Therefore, as long as the sun and the moon exist, this energy is repetitive. It is a continuous cycle, thus marine energy could be generated and

utilised sustainably. Secondly, water area accounts for 71% of the earth's surface. Therefore, regarding the existence of the total body of seawater, abundant marine energy could be transformed into giant usable energy. More importantly, MRE is a form of clean energy, the use of which will not cause pollution to the external environment. Even if there is devastating damage, compared the extent of damage to other forms of energy, the environmental impact of MRE is considered to be minimal.

Renewable energy basics and its growing importance

History is replete with the examples that people have been using wind power for running ships, grind grains and propel boats since almost 5000 BC, and pumping water in Japan and China since almost 2000 BC (Stoddard 2012). Renewable energy has replaced the use of windmills as it has become widely available and comparatively cheaper. It can be said that the last few decades have evident of the various ventures on the energy crisis and stern application of laws regarding emission controls. Many countries have considered alternative sources of energy to mitigate GHG emission in handling the expected effects of climate change (Karim et al. 2018).

RES devises the ability to produce energy services with virtually zero emissions of GHGs and air pollutants, which can be used as indigenous resources, e.g. 'green energy', 'clean energy' or 'alternative energy', etc. (Ottinger et al. 2005). The significance of the RES has been endorsed not only by the scientific experts but also by judicial authorities for environmental protection as well as combating climate change. A case, No. C-379/98 in the Court of Justice of the European Union (CJEU) relating the parties 'Preussen Elektra AG' v 'Schhleswag AG' [2001], is an example in which it was mentioned as "the use of RES for generating electricity is very useful for environmental protection as it reduces the emissions of GHGs; one of the key causes of climate change".

It is observed more than 10% growing trend annually in the reliance on RES by the global community since the late 1970s (Development 1987). Figure 1 illustrates the total primary energy consumption worldwide for the period from 2007 to 2017. A research report projected that the use of RES helped in producing 13.2% of world's primary energy generation in 2012 22% in 2013 and estimated to increase to 26% by 2020 that will be greater than the contemporaneous collective electricity needs of India, Brazil and China (U.S. IEA 2015). It depicts a significant increase in public investment in RES over the globe; around the US $ 16 billion in 2015 and US $ 17 billion in 2016 (IRENA 2017), which have attracted investments from the private sectors to use RES in electricity generation. Eventually, it took only 5 years that the RE capacity outstripped the electricity generation from fossil fuels (UNEP 2017).

Renewable energy in the U.S.

RES; tidal, wind and solar energy production are more competitive or less expensive as compared to electricity-driven from fossil fuels, and rapidly growing in the U.S. than that of any other source of electricity. Meanwhile, coal has been surpassed by natural gas and become a primary fuel for power plants. A report for the Business Council on Sustainable Energy represents a decreasing trend in GHG emission in the U.S. in 2017 as lowest as it was in 1991 (Funkhouser 2018).

It is a good sign for improving climate change trends. The shift from emissions of carbon dioxide, fossil fuels, GHGs, and other earth-warming gases to renewable energy is a key part of the universal struggle to reduce the climate change effects by minimising our dependence on conventional fossil

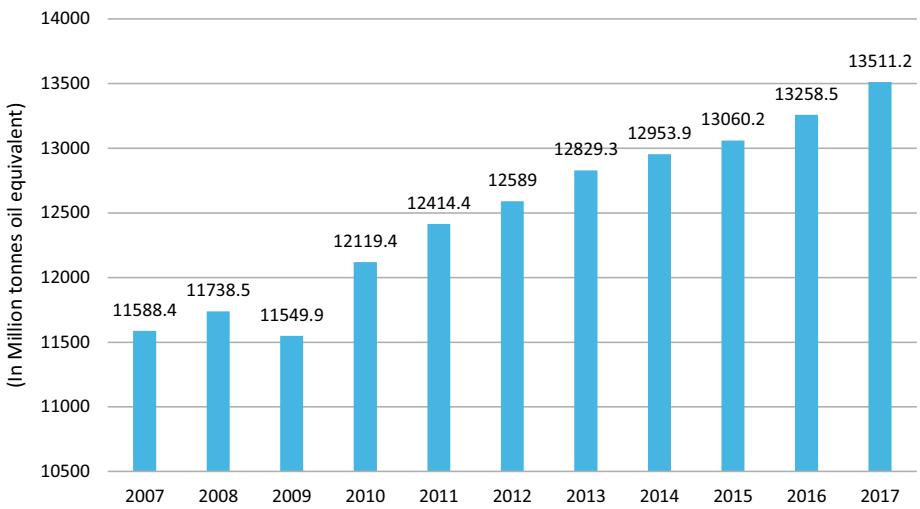


Fig. 1 Total primary energy consumption (2007–2017). *Source*: British petroleum statistical review of world energy (BP 2007, 2009, 2011, 2013, 2015, 2017, 2018)

fuels. On the other hand, this development would not be possible without the government's financial support. Global clean energy investment bounced back to the second highest on record amount. The U.S. chased the investments to 2016 levels in this domain. Investment in clean energy progressed to the US $ 333 billion in 2017 worldwide, which was second to the US $ 360 billion consumed in 2015. Out of which, the contribution by the U.S. held around 17% or the US $ 57 billion (MNEF 2018).

The legal system for the development of MRE in the U.S

The development of MRE law in the U.S.

The west and east coast of the U.S. faces the vast Pacific Ocean and the Atlantic Ocean, respectively. Its abundant marine energy grants America an innate superiority in the relevant development. As early as the mid-twentieth century, the U.S. began to attach importance to renewable energy. At that time, the government has recognised the important strategic status and economic significance of the oceans and began to develop the science and technology regarding marine energy utilisation. Since the 1980s, the American utilisation of wave energy reached the practicality and commercialisation level. The U.S. is also a pioneer in ocean thermal energy research. In 1979, a sea thermal power station was built for the first time in Hawaii (MOE 2015). The experimental research on salinity gradient by the U.S. has gained valuable experience for further commercialisation (Wu 2006).

The study of the Electric Power Research Institute found that American marine energy has great potential to generate electricity. Wave energy alone could generate 100 gigawatts of electricity, equivalent to the traditional hydroelectric power. In general, wave energy, offshore wind energy, and tidal energy could meet 10% of the nation's electricity consumption (U.S. DOE 2013). The leading position of the U.S. in MRE development is not only reflected in its technical innovation but also refer to the establishment and protection of MRE related legal system. Since the 1970s, the American government has issued six comprehensive Acts relating to renewable energy (Tao 2009), and these Acts will be discussed in the following part.

Outer continental shelf lands act

In 7th August 1953, the Act of Outer Continental Shelf was introduced, which was later amended and enacted since 26th December 2013. It was enacted to provide for the jurisdiction of the U.S. over the submerged lands of the outer continental shelf, and to authorise the U.S. Department of the Interior to lease such lands for certain purposes (U.S. Congress 2013). It governs the proceedings of wind energy projects and the role that the U.S. Federal Energy Regulatory Commission plays in licensing marine hydrokinetic projects. It is pertinent to mention here that a preliminary permit is required (for up to 4 years) under the Act, first to study the development of a hydrokinetic project at an identified site, and eligible developers to test new technologies need to use the Hydrokinetic Pilot Project Licensing Process. However, the permit does not authorise the developers for construction. Instead, it gives them the priority to study a project at the specified site within the specific duration of such permit. The Federal Energy Regulatory Commission (FERC) of the U.S. governs various similar activities under this Act, for example, FERC, has signed an agreement to coordinate hydrokinetic projects development in California on 18th May 2010, it has issued first Pilot License for Tidal Power Project in New York on 23rd January 2012, and so on (FERC 2019).

The national energy act of 1978

The Energy Tax Act, which is a subsidiary act of the National Energy Act of 1978, aims to shift the nation from mere enlarging oil and gas supply towards energy conservation in order to promote renewable energy and improve fuel efficiency through taxes or tax credits. It also offers a variety of preferential tax policies and a 5-year accelerated depreciation scheme for renewable energy. The Public Utility Regulatory Policies Act as a part of the National Energy Act, is intended to support larger usage of domestic, local or national renewable energy (Tait 2017). The law forces monopoly in electric utilities to purchase electricity power from other more efficient producers. The law creates a free market by reducing the restrictions on the domestic electricity market and using tax measures. This free-market approach presents investment opportunity and government encouragement for the further development of environment friendly technologies or renewable energy projects. The significance of this Act is that the new energy project developers were relieved of a wide range of federal and state management measures (Tomain 2008).

The energy security act of 1980

The Energy Security Act of 1980 consisted of six major acts, stipulating the systems of solar energy, ocean thermal energy, conventional energy, and geothermal energy, respectively (U.S. Congress 1980a). The Ocean Thermal Energy Conversion Act, which is one of the sub-acts, aims to promote the development of ocean thermal energy conversion (U.S. Congress 1980b). The ocean thermal energy is a new form of energy, which will potentially reduce

the dependence on foreign sources of oil. This Act firstly authorises the American National Oceanic and Atmospheric Administration to construct, own, locate and carry out the commercial operation of the thermal energy conversion equipment. Secondly, there is no need for the thermal energy conversion equipment to obtain a lease from the government or pay taxes to the federal government. Such provisions aim to encourage the commercial development of MRE. The Act authorises the U.S. Coast Guard the obligations to ensure safe construction, the operations of thermal energy conversion equipment and to prevent pollution as well as clean up any discharge of pollutants. The purpose of which is to ensure that pollution does not change the thermal gradient in the relevant maritime areas (Woodford 2020).

The energy policy act of 1992

The Energy Policy Act of 1992 establishes a policy to support the development of renewable energy, which includes tax cuts, the opening of the transmission network, development of power developers and encouragement of competition in the electricity supply, etc. (U.S. Congress 1992a). The Act sets goals, amends utility laws, and creates mandates to increase the usage of clean energy and develop general energy efficiency in the U.S. The provisions of Chapter Seven are designed to provide incentives for clean and renewable energy, to reduce the nation's dependence on imported energy, and to promote energy conservation in buildings (U.S. Congress 1992b). The Act also directs the federal government to decline the utilisation of energy in federal buildings when feasible and to integrate the use of alternative fuel vehicles at state and federal levels. The Act authorises tax incentives and strengthens marketing strategies to promote renewable energy technologies in an effort to encourage production and commercial sales.

The energy policy act of 2005

The Energy Policy Act of 2005 is divided into 18 chapters, which highlights the position of modern or renewable energy. For various forms of energy production, the act provides loan guarantees and tax incentives to support the development of the energy industry. It improves ocean energy sources, including tidal power and waves energy as renewable technologies (U.S. Congress 2005). It necessitates the energy department to conduct ample research and report on present natural energy resources including tides, waves, solar and wind. Regarding tax reduction policies, $500 million Clean Renewable Energy Bonds were used for renewable energy projects conducted by governmental agencies and $2.7 billion was used to extend the renewable electricity production credit (Blazev 2016). The Act also requires the Department of Energy to include marine energy in the catalogue of renewable energy and enables marine energy to qualify for the renewable energy project construction funds (Lin 2007).

The Ocean Renewable Energy Coalition was founded on 20th May 2005. It is the only national trade association exclusively dedicated to supporting hydrokinetic and marine energy technologies from clean and renewable marine resources. The coalition is working with academic scholars, industry leaders, and other interested NGOs to support and promote renewable marine technologies and increase awareness schemes of their huge potential to help in securing a reliable, affordable, and environmental-friendly energy future. It also aims to promote the marine energy sector from the perspective of commercial operation (Zhao 2012).

The energy independence and security act of 2007

In 2007, U.S. President Bush signed the Energy Independence and Security Act of 2007 (Public Law 110-140 2007). The Act takes energy efficiency, energy conservation and promotion of renewable energy as legislative priorities, and pushes energy conservation, energy efficiency as well as development and utilisation of new energy in the U.S. towards a new height. In Chapter Six, Section Three, it provides the study and development of marine and hydrokinetic renewable energy in details (U.S. Congress 2007). Firstly, it provides the normative definitions of hydrokinetic and MRE, which includes the free-flowing waters of waves, tides, artificial rivers and lakes as well as the ocean temperature difference. Secondly, it provides that the government should carry out research projects regarding MRE in order to promote study, research and develop new technologies. The government should also establish a reporting system to provide feedback on the impact of MRE on the environment, and propose methods to protect nature. Finally, the Act calls for the establishment of a national marine and hydrokinetic renewable energy research, development and demonstration centre to promote the research and innovation of new energy technologies and to accelerate the practical application of MRE.

The American clean energy and security act of 2009

The House of Representatives approved the American Clean Energy and Security Act in 2009 (U.S. Congress 2009a). The Act requires, from the beginning of 2012, electric power suppliers generating more than one million megawatt-hours per year to meet 6% of their electricity needs through RESs (U.S. EIA 2017). This requirement will increase year-by-year, and reaching 20% by 2020 and so on with more than 15% of every State's power supply to come from RESs. However, the country has managed to utilise and contribute 17.5% of the renewable energy to the total energy mix of

the U.S (U.S. EIA 2020). It also stipulates subsidies for new energy technology providing new subsidies worth $90 billion to renewable energy until 2025 (NCSL 2018).

The American energy act of 2011

In 2011, U.S. President Obama signed the American Energy Act of 2011. It expands the federal administrative power, reduces the cost of renewable energy development, and creates a new system as well as provides more freedom for renewable energy developments. The Act establishes a rigorous or streamlined programme for the permitting of a vast variety of energy projects. The Act also removes numerous long-recognised obstacles under federal law to ensure timely action by federal agencies on permitting applications and other energy projects-related requests. The Act forms newly accelerated agendas for the review of agency arrangements by the courts. It also seeks to preserve the ability of federal agencies to exercise their discretions in the management of limited agency resources as well as in pursuit of policy priorities (IER 2011).

The 2012 annual report of 'Marine Energy System Implementation Agreement' states that the U.S. President Obama signed an executive order in 2010, which calls for the establishment of a new National Ocean Council and the adoption of a new national ocean policy to improve the management of U.S. marine waters and the Great Lakes. Later in 2012, the National Ocean Council began regional marine planning in many parts of the country through releasing a draft implementation plan, which will facilitate the efforts of the U.S. Marine Resources Energy Generation Plan (MREA 2012).

In the early U.S. new, modern or renewable energy development, there are some specialised new energy Acts. However, from the beginning of the 1980s, there is a decrease in this kind of specialised Acts. The contents are largely replaced by comprehensive Acts. The U.S. legislation of renewable energy and new energy is a large-scale comprehensive Act based on supplemented by various sub-acts. In every comprehensive energy Act, there are sub-acts, which stipulate renewable energy to ensure that it is concrete and integrate.

The national ocean policy implementation plan of 2013

The U.S. has launched and enforced the National Ocean Policy Implementation Plan through the National Ocean Council in April 2013. The Implementation Plan is not a new law but demonstrates the commitments to streamline the regulatory procedures. It establishes a substantial step forward to the National Ocean Policy, and also spreads the awareness amongst the marine industries regarding its mandates; new interagency processes and actions (Marriott 2013).

The U.S. Federal agencies will take this Implementation Plan to identify efficient, practical, and responsible actions to support or promote the productive, healthy, or resilient coastal and oceanic waters flourishing coastal communities, protecting a safe, strong, secure, or sustainable marine economy and turning it into the circular economy ultimately. The Plan was proposed to support, strengthen and build a new partnership or to manage the existing relationships, and to open extensive participation from various stakeholders or the public in decision makings having an impact on the coasts, oceans or Great Lakes. The fundamental objectives of the plan included providing local people with mechanisms or scientific tools to sustain or improve the quality of life (Whitehouse 2012).

The observations on the U.S. MRE system

The renewable energy quota system

According to the definition provided by the U.S. Environmental Protection Agency, renewable energy quota system means that among the power construction of a State or a region, the market share of electric power generated by renewable energy is stipulated by law mandatorily. Electric power generated by renewable energy can be traded between regions within its quota, which is in order to resolve the differences between regions in the development of RESs (U.S. EPA n.d.).

It is observed that the U. S. has successfully carried out the renewable energy electric power generation quota system. The Energy Policy Act of 2005 requires that among the company's total electricity production, there must be a certain proportion of electricity produced by renewable energy. In addition, this percentage should increase year by year. It is to ensure a steady and continued growth in the market share of renewable energy power generation (Ren et al. 2002).

Government financial subsidy system

The expenditure on the exploitation of marine energy is enormous, and the individual enterprise is difficult to support relevant energy research and development. Therefore, in order to encourage the advancement of technology and promote the substantiation and commercialisation of marine energy, the U.S. government provides large-scale subsidies for the research of new technology and utilisation of marine energy power generation (U.S. DOE 2016). The American Clean Energy and Security Act of 2009 stipulate subsidies for new energy technology providing new subsidies worth $90 billion to renewable energy until 2025 (U.S. Congress 2009b).

What are the subsidies?

The U.S. had been using tax inducements and other strategies to encourage national fossil fuels production in the past, e.g. the Revenue Act of 1916; the producers of oil and natural gas have been benefited the most up to the mid-2000s. Later, the U.S. government decided and realised the need to start reducing GHG emissions. It was the breakthrough when a much larger share of support had been exercised to encouraging renewable energy, promoting energy efficacy, and the development of alternative fuel motor vehicles, e.g. fuel-cell, hybrid cars, etc. (Funkhouser 2018). The list of subsidies can be quite long depending on different perspectives. For example, renewable energy support programs for the residents and businesses located in California includes 212 items comprising federal as well as state-run programs (DSIRE n.d.). However, the policies vary from state to state.

Figure 2 illustrates the details of energy consumption by sources in the U.S. and further reveals that renewable energy takes 10% out of the total energy consumption. It is also pertinent to mention here that tax credits for renewable permit homeowners and utility developers to take 30% of the cost of wind, solar or fuel-cell project off their taxes, and 10% to other technologies, e.g. geothermal, combined heat and power systems, etc. At present, most of the credits are scheduled to decline or withdraw by 2022 (U.S. DOE n.d.). A certain percentage of electricity generation, usually by a certain date is required by various states to be generated by renewable sources. However, the 'renewable portfolio standards' vary; California and New York target for 50% by 2030, Vermont aims 75% by 2032, whereas 13 states have no such standards (DSIRE n.d.).

Renewable energy fund system

The creation of a renewable energy fund could provide financial help to the development of renewable energy, alleviate the fund shortage pressure of renewable energy developers and improve their enthusiasm. The U.S. government provides for a public benefits fund system, which is a direct extraction of 1–3% of the retail electricity price. It, meanwhile, includes specialised contributions of some enterprises. The public benefits fund aims to encourage renewable energy development, provide incentives for renewable energy equipment placement, offer loans to renewable energy development companies, and help those renewable energy projects, which fails to obtain finance through market competition in obtaining start-up capital (Jiaru 2009).

The U.S. department of energy funds management system

Regarding the authorisation of appropriations, section 636 of the Energy Independence and Security Act of 2007 provides that the Congress appropriate funds to the Department of Energy for its direct use (EISA 2007). Firstly, it facilitates the funding channel and avoids the constraints between various government departments as well. Secondly, the government provides financial support to key areas of renewable energy in accordance with the current economic development needs. Thus, the use of capital is more focused, and the effect is more obvious. Besides, regarding the post-operation of projects, the emphasis is put on state macro control. The Department of Energy dominates the management of the applied projects directly and also ensures the recovery of the used cost of funds. It could guarantee the operation of projects is according to the national renewable energy policies and ensure the fiscal revenue (Huang 2012).

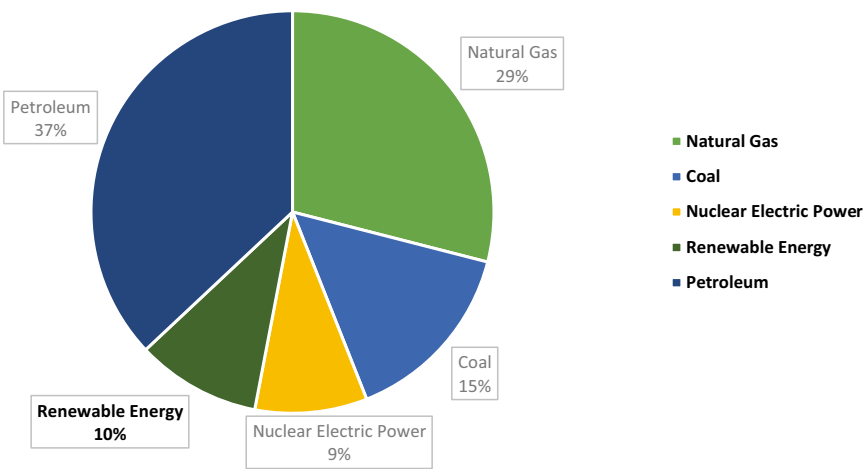


Fig. 2 The U.S. energy consumption by various energy Sources, 2016. *Source*: The U.S. energy information administration, monthly energy review, Table 1.3 and 10.1, April 2017, Preliminary data (Funkhouser 2018)

MRE and the U.S. government agencies

In the U.S. numerous entities support the government financially or technically in the field of MRE from the perspectives of research and development, which also includes the U.S. energy department. The activities related to wind and water have been organised or administrated through a number of separate offices, e.g. National Science Foundation (NSF), Water Power Technologies Office (WPTO), the Department of Defence, and the other National Laboratories supported by the U.S. energy department (Lehmann et al. 2017). Following is a list of the key entities in the U.S., which play their significant or indifferent role in the development of MRE: (Lehmann et al. 2017)

1 The Office of Wind and Water Power Technologies.
2 The U.S. Department of the Navy.
3 National Laboratories.
   a Pacific Northwest National Laboratory (PNNL).
   b Sandia National Laboratory (SNL).
4 Bureau of Ocean Energy Management (BOEM).
5 National Science Foundation.

Legislative features of the U.S. MRE

Combination of comprehensiveness and specialisation

In the U.S., energy legislation is comprehensiveness oriented. It regulates energy development and utilisation of every kind and pursues energy diversification. On the other hand, there are specific provisions concerning MRE in the legislation to suit the characteristics of marine energy development and ensure operational practicality (U.S. EIA 2018). For example, section 17213 of National MRE Research, Development, and Demonstration Centres extensively protects various pertinent stakeholders (LII 2020).

Emphasis on government financial participation

Given the financial needs of MRE development projects, the legislation requires that the government provide subsidies through fiscal income to help the operation of those projects. Meanwhile, the system of tax incentives and the establishment of funds encourage the development of related enterprises and also promote the expansion of MRE projects.

Emphasis on the development of new energy and encouragement of technical innovation

The American Clean Energy and Security Act of 2009, for example, attaches importance to new energy and renewable energy. This Act requires that by 2020, more than 15% of every State's power supply must arise from renewable energy. On the other hand, it emphasises technical innovation. This Act stipulates that the investment in basic scientific research and development has to reach $20 billion by 2025 (CAS 2012).

Adaptation and resiliency to ocean acidification and climate change

One of the salient legislative features of U.S. MRE is to strengthen the resiliency of coastal communities, environments of marine, and facilitate their adaptation to impacts of ocean acidification and climate change. All the stakeholders have a responsibility and an opportunity to decrease the vulnerability, and to improve the human's resilience as well as natural systems to the impacts of climate change.

The scale, pace, and scope of climate change have severe effects on recreation and tourism, flood protection, jobs or other economic activity, food, and cultural heritage. Changing ocean temperature, increased severe storm events, the rise in sea-level, rapid erosion, and saltwater intrusion depict serious as well as increasing threats to low-lying coastal communities by loosing of arable land, flood inundation, destruction of infrastructure, and the potential displacement of coastal communities or population. On the other hand, the situation of climate change predicts lower water levels of the great lakes through altering habitats, water supplies or cycles, and cost-effective usages of the lakes. Also, ocean acidification and changing ocean temperature may have significant effects on the ocean ecosystem structure and its function, food webs, and several marine species (Whitehouse 2012).

Discussion and analysis

In this study, we have looked at the legal systems and challenges posed in the development of MRE from the perspectives of both the government and industry. It has also been rationalised that what lessons can be learned from existing laws or policies and current practices at various levels to comprehend enabling the conditions to step forward towards a supply of energy generations comprising a significant share of marine RES. In addition, this study discusses the various

prerequisites for successful developments with regard to marine RES along with the governance or legal domain.

Prerequisites for effective developments

Extensive administrative or governance problems for MRE, e.g. failures in planning and policing can be observed at the federal level. The key factors responsible for inefficient marine renewable, and for sustainable energy conversions may be summarised as; firstly, short-term federal tax policy and uncertainties amongst the investors due to congressional politics and decisions. Secondly, the current regulation for marine energy developments is vague and incoherent. The third fundamental concern is the absence of a nested system for overlapping jurisdiction as well as energy governance amid federal and states level. Some scientific obstacles, e.g. grid connection, the security of energy supply, and device development is also inevitable, which need the due solution. The assessment of these conditions reveals that adequate initial capacity in relevant federal government institutions exists to offer financial support that provides the initial impetus for the developments in MRE sector (Lange et al. 2018).

Transferability of local or state level programmes

A spatial planning process can engage developers with communities which the developments or advancements in the marine environment may affect, and may also be helpful in successful project implementations. These meaningful engagements amongst the various stakeholder is an imperative prerequisite for credible government decisions to build well-formed groups of stakeholders who eventually support energy developments (Kemp et al. 2007). Focused government commitments and better departmental coordination remain major prerequisites for successful implementation of the marine energy regulations, which further enforces sustainable future energy mix.

Policy implications

Amongst the prerequisites of any form of development, energy is the most important one, especially to achieve sustainable or global inclusive development. It is anticipated that besides current levels of energy supply or generation, hundreds of millions of people would deprive of the elementary energy services by 2040, which is mostly because of 30% increase in energy demand globally (IEA 2016). Any form of development will remain incomplete unless until the participation of such a large population. The consumption of MRE sources for energy generation would be a favourite choice since fossil fuels have a number of drawbacks and some integral limitations as they emit GHGs, which leads to climate change or global warming. Moreover, hypothetically and to some extent, empirically tested endless MRE brings comprehensive economic growth (Jenniches 2018). However, along with their great potentials of the MRE infrastructures, it also poses some barriers or challenges.

Opportunities

Energy security, socio-economic development, energy access, mitigation, and climate change are the four main sectors where the MRE suits sound. The stats reveal that in 2009, almost 1.4 billion people in the world, of which 85% from the rural areas, reportedly had no access to electricity (IEA 2010). Whereas according to a report of the world health organisation (WHO) under the United Nations Development Programme (UNDP), 1.2 billion of the additional population was proposed to require the need to access the electricity by 2015, and 1.9 million more people to have modern or renewable energy to meet the Millennium Development Goals for decreasing the population count under poverty level by 50% (WHO-UNDP 2009). The transition from conventional fuels to modern MRE access refers to moving towards environment-friendly or clean energy production. Various steps have also been taken in this regard in order to increase access to modern electricity sources or cleaner cooking facilities (REPN 2009).

Since the last decades, economic growth has been the most imperative governing element behind growing energy demand or consumption. The demand for more flexible or sophisticated energy rises as the economy grows. A shift from utilising traditional fuels to advanced quality electricity demonstrates economic growth (Kaufmann 2004). Clean or reliable MRE is an important element of the fundamentals for human development, which may further add to increase health and education quality, income generation, and also decreasing the poverty level with the alternative and cheap energy facilitation (Kaygusuz 2007). Government bodies or policymakers at state and federal levels have also sustained the local, domestic or national market in the business of renewable energy technology by offering tax incentives (Sen et al. 2016).

Energy security denotes the secured supply of energy, whereas renewable energy signifies a reliable and cheaper energy generation eliminating the problem of price volatility. Domestic renewable energy opportunities have been helpful to ensure energy security by spreading the choice of supply and decreasing the reliance on orthodox energy sources. Energy demand has a positive relationship with economic growth rate. Therefore, there may be an acute energy shortage due to the growing pressure on present resources as well as the supply and demand gap in domestic industrial sectors.

Climate change mitigation significantly influences the growing demand for RE, which necessitates due actions to control over the critical impacts of climate change. Various

concerted global actions can be launched to limit the global temperature rise. The sustainable development comprises adaptation towards climate change (Parry et al. 2007). Dams linked with hydropower plants aids in managing floods and droughts. These are likely to be in a greater frequency with global warming or climate change, and have become one of the significant motives of building such dams (World Commission on Dams 2000). Correspondingly, afforestation along river banks and coasts decrease the bank or coastal erosion.

Barriers

Barriers to the developments of MRE mean the hindrances or obstacles in the developments and usage of renewable energy forms. It demands to introduce new policies, plans or programs as well as technological advancements to overcome these barriers (Verbruggen et al. 2010). The lack of statistical information, detailed dataset, and awareness regarding the expediency of the MRE as compared to the energy from the fossil fuels, regardless less of the technology type, stand still as one of the major barriers for the development of RE (Sen et al. 2016). Peak stages in the price of crude oil in 1973, 1980, 1991 and 2008 demanded the alternative energy resources to take place (Sen and Ganguly 2017). That is how people rationalised to adopt RE technologies. Though, there are barriers of public and institutional awareness about the technical and financial perspectives for the implementation of sustainable transitions from orthodox fossil fuels energy productions means to environment-friendly MRE technologies (Henriques and Sadorsky 2008).

Skilled human resources having the specialised training in the renewable energy sector is another issue here. Hardware or machinery related to renewable energy need a skilful operator to make the best use of the technologies of MRE (Martinot 1998). However, this problem mostly lies for developing countries, and the U.S. has already covered enough space in this regard (Mondal et al. 2010). Barriers may also arise from insufficient consideration of cultural or social concerns. Social acceptance may be the significant solution here. This recognition is growing gradually. Eventually, people have awareness and enthusiasm for benefiting from these technologies (Bruce 2009).

We may also observe the institutional barriers in the development of MRE due to a monopoly of existing industry, including public as well as private sectors, with a small number of players, which makes the system highly centralised (The World Bank 2006). Some states still exercise the policies or regulations which directly or indirectly support the monopoly that brings some difficulties in the renewable energy sector. Various states and countries have realised market liberalisation in the 1990s in the energy sector. However, in the U.S., small renewable energy project proposals had to face policy barriers due to the required pertinent scales of regulation (Markard and Truffer 2006). It necessitates modifying the existing policies, laws or regulations to introduce, promote as well as endorse RE technologies. Global financial crisis during 2008–2009 pushed many states and countries to encourage or promote their reliance on the development of renewable energy, which attracts numerous tax benefits and incentives (Lior 2012). Ample financial support from the government, liberalised market policies, and investment-friendly regulations, especially for attracting the private sector, can bring progress in the developments of RE technologies (Sen et al. 2016).

In addition, it is noted that "the present administration is again seeking severe cuts to funds of the U.S. Energy Department division charged with energy efficiency research as well as renewable energy" (Natter 2019). If this happens, it will definitely serve the country perhaps towards the wrong direction since the contemporary world is moving towards the clean and renewable energy, which should be promoted and adequately financed by the governments, especially by the governments of developed countries like the U.S. Given this situation, the burden may be on the private sector in the MRE of the U.S. to meet the energy demands of the country and keep the environment clean at the same time; this merits that the U.S. legal system should adhere more investment-friendly regulations to assist, motivate, and even support the private sector in dealing with any challenge they may encounter during their operations.

Recommendation for RE integration

Financial support

There are multiple approaches of financial support to the deployment of MRE sector, (Abdmouleh et al. 2015a) which drive the proposed recommendations into; removing or adapting subsidies, or proposing brand new or innovative mechanisms for financial support. It is an admitted fact that the subsidies for fossil fuels are not sustainable for the environment or the national economies. The conversion of the subsidy to renewable considers as support to electricity production from RES, which could also aid to progress a range of low-carbon alternatives (Energy Security Institute 2013).

The method of adaptability works as a substitute for radical removal of subsidies. There is a need to generate a competitive market in order to reduce the burden of subsidy or extensive state control, e.g. renewable energy project developers, energy service companies, and various constructors. The incentives offered to the various stakeholders on clean energy projects should ideally be time-bound, perfectly designed, and well-targeted.

Legislative support

In 2013, a broad arrangement of legislative systems which were applied around the world represented that 28 states or provinces and 71 countries had adopted and implemented some form or part of feed-in-tariffs (FIT), 54 states or provinces and 22 countries chosen quotas for renewable power generation or renewable portfolio standards (RPS), and 37 countries and 51 provinces or states in the US and Canada had adopted Net metering policies (Energy Security Institute 2013). The FIT represents the most applied legislative mechanism for the development of renewable energy-related projects because of its several advantages including market stability and offering investment security effectively increasing the volume of electricity generation from MRE sources (Mezher et al. 2012).

Political support

Numerous opinions may be considered regarding the government's role to promote or encourage the development of MRE. The government, as the sole owner of fundamental supply as well as subsidiser of energy, should yield a leading part to make demand and alternative supply-side investments (Abdmouleh et al. 2015b). Legislation for the private or independent power provision may be considered as a first step in assisting state-owned energy utility in order to propose, formulate, and implement technology solutions and clean energy policy. Whereas embarking on more extensive structural separation of the power sector should be considered as a second step from the government side, where the various stakeholders are fortified to engage in power generation as well as in transmission or distribution of MRE technologies (OECD 2013). The situation merits extensive political support from all the stakeholders irrespective of the political affiliation and in the best state's interests. Various political powers or pressure groups should provide their unconditional support to the sitting governments in a promise to make America great, green, and clean from the climate challenges at the same time. In addition, governments can also promote the development of regulations related to renewable energy by holding away investment incentives from traditional energy sources, e.g. fossil fuels towards clean or RESs and setting robust as well as credible long-term objectives.

Technological and environmental support

The energy research institutions, universities, and other international partners should have a collaboration to make sure the technological support for the development of renewable energy. Governments can support and promote the formation of industrial amenities by offering guarantees, encouraging research and development (R&D), low-cost financing, training human capital, managing the transfer of technology, and offering supplementary facilitation for the export of national or domestic technology or equipment (IRENA 2011). Moreover, the research mechanisms should also be wisely chosen in niche areas for having some comparative advantage.

General recommendations

1 Pertinent state departments should rapidly formulate or promulgate the rules, regulations or policies concerning feed-in price, investment and finance, tax, and obligatory market share depending upon the laws related to the renewable energy, to create a potential or healthy political atmosphere for the development of MRE. On the contrary, special legislation for MRE should simultaneously be conceded according to their respective characteristics, which may be helpful to further coordinate and resolve the flaws or inconsistencies in the present legislation system.
2 Contemporary conflicts of policy due to imperfect legislation may be regarded as the key issues that limit the advancement of MRE projects at the state or the local level. Keeping in view the macro policies of the state, local governments can further formulate as well as implement such subsidiary policies as taxation, pricing, environmental protection, finance, and subsidies compatible with local situations in order to resolve and coordinate amongst the potential conflicts of various function of relevant departments.
3 The scope of environmental education in target population demands to be expanded up to a significant level. Also, some more related plans should be launched in order to promote public awareness regarding MRE.
4 Renewable energy projects should be registered as a clean development mechanism (CDM) projects at the United Nations and earn carbon credits. The Kyoto Protocol provides CDM, which refers to a mechanism of flexible carbon emission-reduction that allows entities to realise revenues through shifting emission reductions into carbon credits or tradable assets through the apparatus audited and governed by the United Nations (UNFCCC n.d.).

Strengthen, promote and support coordination on the provision or development of guidance, training, information, support, and tools for adaptation practitioners. It is also pertinent to design or formulate, evaluate, and implement adaptation policies, tools, strategies or legal system for MRE in order to promote informed decisions or decrease vulnerabilities.

Conclusion

This study provides a comprehensive assessment over the U.S. MRE legal system. The U.S. model could be summarised as; firstly, to fix government's administrative participation through relevant laws; secondly, strengthen its financial support; thirdly, use tax to implement preferential policies for establishing a clear fund use system; and fourthly, set up a suitable management system for renewable energy development. Along with its development of marine energy, the U.S. also attaches great importance to the establishment of matching environmental protection system. Besides, the U.S. establishes environmental monitoring as well as reporting systems focusing on energy development and environmental protection, realising the prerequisites for sustainable development.

Fruitful laws, policies and regulations enable sustainable deployment or development of MRE technologies, e.g. timescales, investor's confidence, knowledge development, sustainability, certainty, equitable use, etc. Successful implementation of a legal system depends upon the formation of government policies; comprehensive policy framework, targeted and swift targeted policy actions to support development in the MRE sector. Good policies need to be adaptable and flexible, well-planned for large-scale arrangement, healthy or fruitful competition over sites, managing impacts within the potential environment, ensure a balance between exploitation and sustainability.

In short, a suitable regulatory framework for MRE could potentially integrate and strengthen observations from the observing systems, research sites, and nation's protected areas into a coordinated framework to track fluctuations in the state of coastal communities or ocean environments. It is strongly recommended to determine, then control and regulate the impacts of ocean acidification and climate change interacting pressures or stressors on social, economic, and ecological systems. Keeping in view the in-depth discussion of this study, it is, therefore, concluded that the U.S. has a comprehensive legal system for the development, administration or smooth management of MRE. However, it has to timely intersect with the opportunities and barriers in the light of the administrative or legal framework and enhance its institutional structure for the successful implementation as well as to be competitive for the attainment of required goals of MRE.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interests.

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