Renewable Energy Systems in the European Union: strengthening European leadership in achieving climate and energy goals

An IEEE European Public Policy Committee Position Statement

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The IEEE European Public Policy Committee (EPPC), representing a large community of European engineering professionals, calls on European Union (EU) policy makers to take immediate action to increase the use of renewable energy in Europe with a view to consolidating the European leadership in this field, reducing the environmental impact of human activities on the climate, and creating new jobs.

Recommendations

The IEEE EPPC strongly endorses and welcomes:

1. All EU policy initiatives which are aimed at reducing the use of fossil fuels and at cutting greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

   In addition to tackling the climate emergency, these measures could also play an important role in leading the way "from fragility towards a new vitality"[1]*;*

and recommends that EU policy makers:

2. Promote the reduction in the costs of Renewable Energy Systems (RES) at all power levels, from watts to mega-watts, by also considering the costs of energy generation, transmission, distribution and storage, together with their ancillary services. This would minimize the long-term cost of the energy transition and avoid that some Member States lag behind, especially those that have a low share of electrical energy generation from renewable sources in their energy mix.

   The energy generation from renewable energy sources has to be pushed in all EU Member States, by also exploiting geographical differences among neighboring countries. These can benefit from the inherent time shift between different power production profiles, with a beneficial effect also on the required local storage capacities. Coupling among energy sectors, including electricity, transportation, and water/space Heating and Cooling (H&C), can also help provide the flexibility and price responsiveness that is required for variable RES integration. Increasing R&D funding and stimulating technology transfer would be beneficial

[1] https://ec.europa.eu/info/sites/info/files/state_of_the_union_2020_letter_of_intent_en.pdf

for having products that show high performance at a lower cost, with a positive effect on the European leadership position in this field.

3. Promote solutions that contribute to further exploiting renewable sources, relieving electrical energy distribution stresses, and improve the effectiveness of investments for both transmission and distribution issues. This includes both electrical energy storage systems and demand flexibility. The former includes reversible fuel cells, redox flow batteries, compressed air systems, sectorial coupling with heating, in addition to Lead (Pb) or Lithium (Li) batteries. Demand flexibility requires dedicated technologies, regulations, markets and practices.

   Storage technologies, at different power scales, are instrumental in exploiting renewable energy, not only for shaving peaks in power production, but also for reducing the impact of some industrial processes. Integrating electrical vehicles into power systems as part of the storage infrastructure would be an avenue to exploit their high storage potential.
   Demand flexibility, i.e., the reduction, increase or shift of the demand for electricity within a specific time frame, can also help compensate the differences between the RES power production and load absorption curves. This requires smart technologies that allow system operators to effectively interact with the various sources of electricity demand.

4. Work towards the development of industry standards that make RES and storage systems compliant and successfully interoperable, in order to integrate them into the grid and with the transportation system through smart and efficient power processing interfaces, e.g., switching converters, while preserving the overall system stability.

   The effective integration among RES and storage systems, the flexible load and grid interaction require a high level of standardization among the industrial products, at the hardware level as well as at the communication and software level. Indeed, the role of ICT standardization will be as important as the one referring to power interfacing technologies.

5. Promote studies on the life cycle assessment of renewable energy technologies and systems, from production to "second life"[2], as well as of components and materials reuse and recycle strategies.

   The large amount of waste resulting from obsolete RES needs to be duly treated in order to have either a second-life system or recycled components and materials.

6. Continue to include renewable energy at the top of their policy agenda, as this sector has the potential to sustain employment and create new jobs in the manufacturing, R&D, installation, maintenance, and recycling of renewable energy systems or parts/components thereof.

[2] "second life" refers to the reuse of a system that no longer meets the requirements of its initial application, but that can still be employed in less-demanding contexts.

EU policy context

In its revised Directive on the use of renewable energy sources[3], the European Union lists policy objectives for a future legislative framework on renewable energy at the EU level. A number of these policy objectives are outlined below, with the EPPC's recommendations offering an avenue to achieve them:

- to reduce greenhouse gas emissions in order to achieve the 2015 Paris Agreement goals;
- to increase the share of energy from renewable sources in the Union's gross final energy consumption by pushing each Member State to stay above a baseline value;
- to reduce the cost of renewable energy;
- to integrate renewable sources into the energy system, by increasing its flexibility and ensuring grid stability;
- to improve transmission and distribution grid infrastructures, and to develop intelligent networks, storage facilities and interconnections;
- to mainstream the use of renewable energy in the transport sector in order to reduce greenhouse gas emissions;
- to move towards the concept of zero-energy buildings by fostering the use of renewable energy and self-consumption, improving energy efficiency levels, and promoting the adoption of combined heat and power (CHP) and of renewable heating and cooling systems;
- to increase the participation of consumers in the energy system by empowering them to generate, self-consume, and store renewable energy;
- to improve cooperation among Member States, including third countries, in order to develop a stronger renewable energy framework that secures future investments in renewable energy in all sectors and safeguards Europe's competitive position in a global market.

Background

Photovoltaic Market

Between 2000 and 2018, PhotoVoltaic (PV) capacity grew by a factor of over 100 [1][2]. In 2017, more capacity was added worldwide from PV than from any other type of power generating technology. This was more than the net capacity additions of fossil fuels and nuclear power combined [1]. In 2018, the single-digit-only growth rate of the global market was counterbalanced by an increased number of countries having a market at the gigawatt level [2]. In the period 2007-2012, the global PV market increased by one order of magnitude [3], mainly due to national policy initiatives and technological improvements. This growth rate has been underestimated in many studies, including those by influential authors and institutions. In an initial stage, long-term and relatively stable incentives pushed the photovoltaic market and total installed capacity. The drastic reduction of incentives discouraged certain industries from further investments on R&D, but it allowed other players to remain innovative and provide high quality products at competitive costs. At the same time, in many countries, the management of high shares of power produced in a very distributed way, including through small photovoltaic and wind energy plants, created problems

[3] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

for energy providers working with more old and rigid infrastructures and limited the production-demand balancing. These issues may have significantly affected the growth of the RES use, especially in some countries [4]. Until 2012, the EU was the leading market for PV technology. In the years since, non-European countries have recognized the potential of this technology and experienced a sudden increase in PV deployment. Emerging countries such as China and India, for example, have substantially invested in RES, especially in wind power and solar energy [4]. Even in the US, in spite of recent national policies promoting traditional energy sources, regional policies at the state level (e.g., California) are pushing wind and solar energy installations as well as storage solutions [5][6].

Wind Power Market

The wind power market is also growing steadily (+11% in 2017 vs. 2016), with the offshore segment showing an impressive increase (+87% in 2017 vs. 2016) [15]. Offshore installation prices are also expected to decrease by 50% in the next five years compared to the previous lustrum [15]. In 2017, wind energy provided more than the 11% of the European electricity demand, with the sector being responsible for the creation of more than 260,000 jobs. Because of the transition from the supported schemes to a competitive market, these figures are likely to drop over the next few years unless a clear political direction is given [15]. Overall, renewable power generating capacity increased by around 9% each from 2016 to 2018, led by photovoltaics and followed by wind and hydropower [1][2].

System's end-of-life and Recycling of Materials

The adoption of RES and the fact that some power plants are going to become obsolete will give rise to issues related to the recycling of materials. Wind turbines have a recyclability rate up to 90%, but more than 15,000 turbine blades, which are made of composite materials, need to be managed properly at the system end-of-life [18]. 96% of the materials used in PV panels can be recycled, but sixty million tons of PV panels waste will be produced by 2050 [19].

Energy Storage Systems and Sector Coupling

In Europe, although penalized by a legislation that has been subject to significant improvements in recent years (see [7] and references cited therein), batteries and other electrochemical storage systems are becoming essential (see e.g. [8]) for both supporting the integration of greater amounts of renewable energy into the electric grid and reducing dependence on fossil fuel generation to meet peak loads. New technologies are also being studied. For example, flow batteries and systems using hydrogen as green energy vector are becoming attractive for both storing excess electrical energy that cannot be injected into the grid and producing gases that reduce the environmental impact of some industrial processes and that can be used in transportation sector as well [20].

The growing number of electrical vehicles that can be connected to the grid is also expected to provide increased storage capacity, but their exploitation will eventually depend on consumer behavior [9], the number of vehicles that can be aggregated, and the features of the local markets [10]. The success of electric mobility, and the consequent increase in units for electrical energy storage, will also give rise to new challenges, such as battery wasting [11] and the difficulty in the use of a battery pack in a second-life application due to the heterogeneity in the design of cells and packs available on the market [12]. A number of European projects [13] has also assessed the pros and cons associated to vehicle-to-grid (V2G) technology.

Sectorial coupling between electricity production and heat production (i.e., space heating and domestic hot water) through the use of heat pumps in combination with thermal energy storage (e.g., as applied in Denmark, where wind power is dominant) is also envisaged to provide further resilience to the energy system while minimizing costs and CO2 emissions [14].

Exploration and exploitation of new technologies

The cost reduction, driven by R&D expenses and deployment policies, made the adoption of RES more attractive [16]. European research has been leading the field of renewable energies, by covering all the aspects, from generation to distribution, from monitoring and diagnostics to power processing systems, to smart grids. Also technologies related to hydrogen use and generation have been developed by European research institutions and centers that have been producing disruptive results at the global level. This knowledge has to be exploited for achieving the objectives of the European Green Deal and it has to be pushed furthermore for guaranteeing the European leadership in the related fields.

Guidance to Member States for their energy transition plans

The growing share of RES in the power mix has necessitated adjustments on the share of conventional power generation sector, which would need to be reduced in order to allow for more energy generation from renewable sources. While there is a mechanism that compensates owners of conventional power plants in such circumstances [17], it has significant costs. With the further growth of RES and less structural demand for conventional power being anticipated, the current compensation system may not be sufficient to keep enough baseload power capacity "on-demand" for when it is needed. An EU-wide policy for tackling this issue would provide guidance for EU Member States which are working on plans for the transition to renewable energy.

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