NEA
NUCLEAR ENERGY AGENCY

NEA Policy Brief: The System Costs of Electricity

January 2019

More information at: http://oe.cd/nea-system-costs-2019

Reflecting the true costs of decarbonisation

- Limiting the rise of global temperature to less than 2°C represents an enormous challenge for the whole electricity sector.
- Decarbonising the electricity sector in a cost-effective manner while maintaining security of supply requires the rapid deployment of *all* available low-carbon technologies.
- System costs are not properly recognised by current market structures and are currently borne by the overall electricity system in a manner that makes it difficult – if not impossible – to make well-informed decisions and investments.

What's the issue?

The future is electric. Decarbonising the energy sectors and the economies of OECD countries will require electrification of not just the transportation sector, but also industry and buildings. Effective action to reduce carbon emissions and to limit climate change depends on the creation of a robust low-carbon electricity sector.

Reducing the carbon intensity of the electric power sector to 50 gCO_2 per kWh (which would be necessary to meet Paris Agreement goals) is a major challenge. This level is one-eighth of the current levels and requires a rapid and radical transformation of the power system with the deployment of low-carbon emitting technologies such as nuclear, hydroelectricity and variable renewable energy (VRE). This will mean phasing out coal and strictly limiting the use of gas-fired power generation.

This change must be approached carefully and with a full understanding of costs and impacts of various technologies. For example, increasing the share of VREs results in large inefficiencies in the entire electricity system.

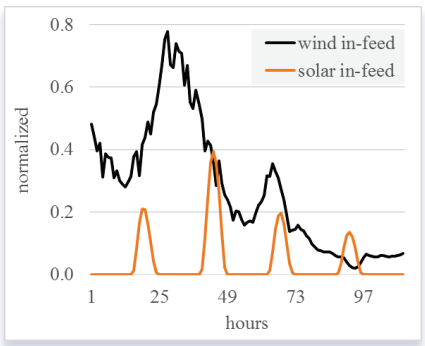
These issues appear as overall system costs, caused mainly by the intrinsic characteristics of variable generation. They also result in significant challenges for the management of the electric system, and volatile and unpredictable electricity prices.

In part because of these effects, the existing electricity market structures make investment in any unsubsidised low-carbon technology economically impractical.

Given the massive investments that the realisation of the decarbonisation transformation requires, it is of paramount importance to create long-term frameworks that provide stability and confidence for investors in all low-carbon generation technologies. The world needs and will deploy large VRE capacity. However, the optimal share of VRE in each country must reflect the full costs of adding this supply – and which will differ from market to market and country to country.

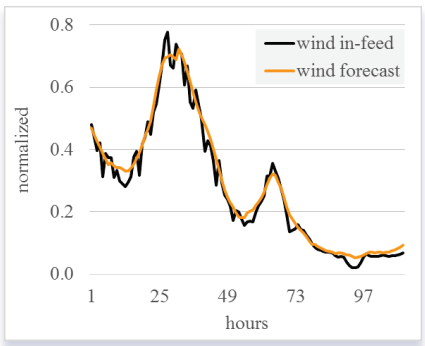
System costs are mainly due to characteristics intrinsic to variable generation

Profile and backup supply costs



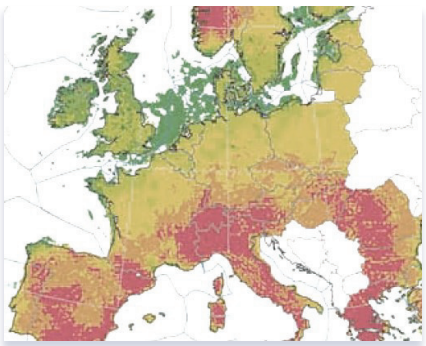
VREs are not always available

Balancing costs



VREs are difficult to predict

Transmission and distribution



VRE sites are distant from demand centres

Source: Hirth, 2015.

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What should policy makers do?

Radically decarbonising the electricity sector to 50 gCO_2/kWh in a cost-effective manner while maintaining high levels of security of supply therefore requires five complementary policy measures:

Recognise and allocate the system costs to the technologies that cause them: For countries to make the most economic decisions regarding their future electricity supply, they must achieve a full understanding of the costs of each option. Just as nuclear waste costs are best internalised into prices for nuclear-generated electricity, the cost of VREs should reflect the costs they introduce into the overall system. Exposure to electricity prices would internalise profile costs, and remunerate each unit of electricity generated at its true value for the system.

Maintain competitive short-term markets for the cost-efficient dispatch of resources: Marginal cost pricing based on short-term variable costs is the appropriate mechanism to ensure the optimal utilisation of existing resources. It is however, not sufficient to bring forward sufficient investment in low-carbon generation technologies. Mechanisms such as capacity remuneration could recognise the value of dispatchability.

Encourage new investment in all low-carbon technologies by providing stability for investors: In creating sustainable low-carbon electricity systems, all low-carbon technologies will need to play a part. However, their high capital intensity requires specific financing solutions as they will not be deployed solely on the basis of marginal cost pricing in competitive markets. This holds for all low-carbon technologies. This is why policy makers have to make tough calls on striking the appropriate balance between out-of-market support and exposure to wholesale market prices for low-carbon technologies with high fixed costs such as nuclear and VRE. Feed-in tariffs (FITs), long-term power purchase agreements (PPAs), contracts for difference (CFDs), regulated electricity tariffs, feed-in premiums (FIPs) or even direct capital subsidies through, for instance, loan guarantees, are all appropriate instruments to achieve long-term security of supply with low-carbon technologies.

Enable adequate levels of capacity and flexibility, as well as transmission and distribution infrastructure: Generation is at the heart of any electricity system, but the electricity system requires frameworks for the provision of capacity, flexibility, system services and adequate physical infrastructures for transmission, distribution and interconnections. The variability of VREs and new technological developments make these complementary services increasingly important. It is also important to recognise the positive contribution to system stability and inertia of large centralised units such as nuclear power plants or hydroelectric dams and to value them appropriately.

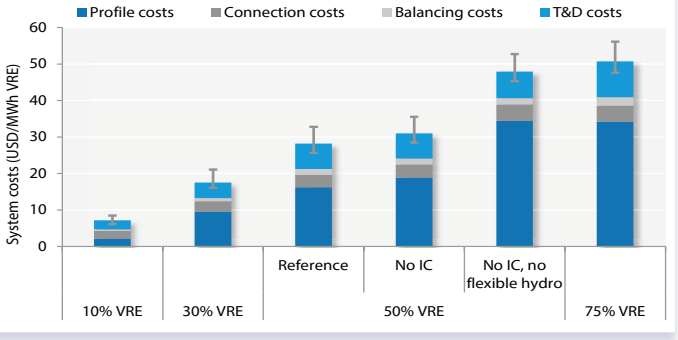
Implement carbon pricing, as the most efficient approach for decarbonising the electricity supply: For countries pursuing policies to reduce carbon emissions, this approach would increase the cost of high-carbon generation technologies, reduce greenhouse gases and enhance the competitiveness of low-carbon technologies such as nuclear and VRE. However, it will also produce losses for some stakeholders – in particular, fossil fuel producers and their customers. The OECD has highlighted the need for appropriate policies to facilitate a "fair transition" for affected businesses and households, particularly for those in vulnerable regions and communities.

Why is this important?

The ultimate objective of policy-making in this area is the decarbonisation of the electricity markets. Current projections are that decarbonisation of the system would require an 85% reduction of the annual CO_2 emissions in OECD countries. Ambitious decarbonisation targets require the optimum use of all available low-carbon technologies, but current electricity markets are not enabling the reduction in carbon intensity necessary to meet the Paris Agreement goals.

Projections in the new NEA study reveal that the true costs of decarbonisation are not being reflected in today's electricity markets. For example, increased share of VRE results in large inefficiencies in the entire electricity system. As a result, system costs (profile, balancing and connection costs, as well as transmission and distribution costs) significantly increase. Existing electricity frameworks lack signals that encourage long-term planning and investment in low-carbon technologies to ensure security of supply and system robustness.

System costs at different rates of VRE penetration



Source: NEA (2019).

Who is working on this?

This study was prepared by the Nuclear Energy Agency, a specialised agency inside the Organisation for Economic Co-operation and Development family. For many years the NEA has analysed different aspects of the costs of electricity. This work focuses on all sources of power generation, examining the plant-level costs, system costs and security of supply. The NEA's goal is to enable policy makers and the public to take better-informed decisions along the path towards fully sustainable electricity systems.

Further reading

NEA (2019), *The Costs of Decarbonisation: System Costs with High Shares of Nuclear and Renewables*, OECD, Paris.

NEA (2018a), *The Full Costs of Electricity Provision*, OECD, Paris.

NEA (2018b), *Measuring Employment Generated by the Nuclear Power Sector*, OECD, Paris.