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THE NEED FOR FINANCIAL AND HUMAN RESOURCES – THE CASE OF OFFSHORE WIND POWER

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INTRODUCTION

Increasing the share of renewables in the European energy system constitutes a large technical challenge, for example in terms of developing and deploying new electricity generating technologies, grid infrastructure and energy storage (Chapters 4-5, 9-12 and 15). A large-scale transformation of the energy system also requires a successful management of non-technical challenges in many areas. We will focus on two such challenges which constitute generic problems in large-scale transformations.

First, the financial sector must address the increasing need for financial resources to enable substantial investments in renewable energy technologies. Until 2020, the European Commission argues that energy-related investments of about 1 EUR trillion (corresponding to about 6 per cent of EU's total investments during the time period) is needed.[1] Although the flow of investments into renewable energy

1 European Commission (2010) *Energy 2020 - A strategy for competitive, sustainable and secure energy*. Brussels, Belgium: European Commission. (COM (2010) 639).

in Europe has increased, it is estimated that this flow will be too low to reach the targets set up for 2020 and there will be an annual lack of funding in the range of 25-50 EUR billion,[2] corresponding to about 1-2% of total national savings in the EU member states. Second, universities must provide specialised competences, in time and in adequate numbers, to support the development and large-scale deployment of a whole range of new technologies. This chapter discusses challenges in securing the necessary financial and human resources for development and large-scale deployment of one of many technologies: offshore wind power.[3]

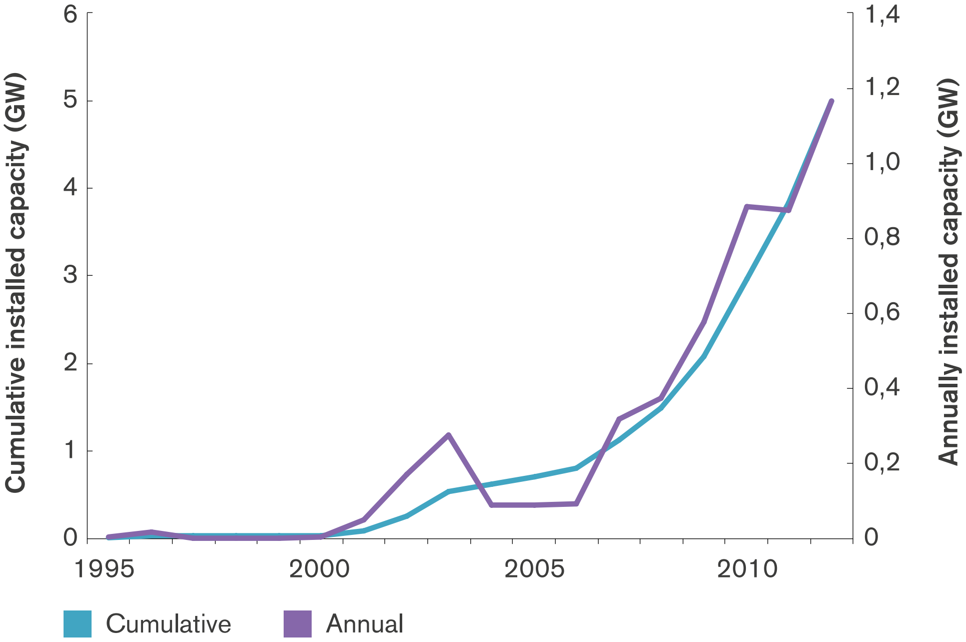

Figure 16.1 Cumulative and annual installations of offshore wind power in Europe. Source: (EWEA 2013)

Offshore wind power has the potential to contribute with significant amounts of carbon-neutral electricity in Europe. The first farm was commissioned in 1991 and the cumulative installed capacity had grown to 4.9 GW in Europe by 2012 (Figure 16.1). The National Renewable Energy Action Plans of the EU member states indicate that by 2020, 44 GW (generating some 140 TWh/year) of offshore wind power could be installed.[4] This could correspond to more than 10% of the renewable electricity in EU 2020. Moreover, the long-term potential is much larger; an elaboration of the vision presented by the European Commission (2011) indicates that more than 800 TWh could be generated from offshore wind power in 2050.[5]

2 De Jager et. al. (2011) *Financing Renewable Energy in the European Energy Market*. Utrecht, the Netherlands: Ecofys, Fraunhofer ISI, TU Vienna EEG and Ernst & Young; Jacobsson, R. and Jacobsson, S. (2012) The emerging funding gap for the European Energy Sector – will the financial sector deliver? *Environmental Innovations and Sustainable Transitions* 5:49-59.

3 Analyses of all challenges for offshore wind power in Europe are provided in Jacobsson, S. and Karltorp, K. (2013) Mechanisms blocking the dynamics of the European offshore wind energy innovation system - Challenges for policy intervention. *Energy Policy* 63:1182-1195; and Wieczorek, A. J. et al. (2013) A review of the European offshore wind innovation system. *Renewable and Sustainable Energy Reviews* 26:294-306. A specific analysis of the case of Sweden is found in Chapter 15.

4 Beurskens, L., Hekkenberg, M. and Vethman, P. (2011) *Renewable Energy Projections as Published in the National Renewable Energy Action Plans of the European Member States.* Petten, the Netherlands: ECN and EEA. (ECN-E--10-069)

5 The average supply of offshore wind power in five decarbonisation scenarios is 818 TWh (234 GW), assuming a capacity factor of 40%. European Commission (2011) *Energy Roadmap 2050, Impact assessment and scenario analysis.* Brussels, Belgium: European Commission (SEC (2011) 1565)..

FINANCIAL RESOURCES

The investment necessary to reach 44 GW by 2020 is estimated at 130 -150 EUR billion.[6] So far, utilities have funded the main part of the investments from their own balance sheets and through debt in the form of project finance from commercial banks.[7] The European Investment Bank (EIB) and export funding agencies (e.g. Danish Eksport Kredit Fonden) have played a vital role by providing capital and taking on a larger part of the risks in order to stimulate commercial banks to provide project finance. An additional funding source is the German Bank for Reconstruction (KfW) with an offshore wind energy program of 5 EUR billion for 10 projects. In line with this, the recently created Green Investment Bank in the UK has offshore wind as one priority.[8] However, the capital may be insufficient as only 3 EUR billion are allocated to a broad range of technologies.[9]

Only a few examples of venture capitalists and private equity firm's involvement have, so far, been seen in the construction of offshore wind farms and in other parts of the industry emerging around these farms. One example is Blackstone's leading investment in the German offshore wind farm Meerwind. A few institutional investors, e.g. pension funds, are also involved in funding offshore wind farms. For example PensionDanmark is together with another pension fund, PKA, majority shareholder in Anholt, the largest offshore wind farm under construction in Denmark.

CHALLENGES IN MOBILISING FINANCIAL RESOURCES

There are several challenges in mobilising the financial resources needed to scale up the deployment of offshore wind farms.[10] To grasp these challenges, it is necessary to understand what makes actors within the financial sector take the decision to invest in an emerging technology or not. The risk-return ratio is key to the investment decision. The following categories of risk can be assessed: *technological risk* that a technology will not operate as expected; *construction risk* that something goes wrong during the construction; *operations and maintenance risk* relates to the uncertainty about operations and maintenance, particularly what it will cost; *market risk* concerns the possibility of predicting the future market both in terms of price and volume; *supply risk* concerns if resources become scarce and *political risk* is the uncertainty about the future regulatory framework. The return depends on cost and income. For the investment decision, both the total cost of the investment and the cost per unit of output are important. To stimulate investments in renewable energy technologies, policies are used to adjust the

6 KPMG (2010) *Offshore Wind in Europe - 2010 Market Report.* Germany: KPMG AG; De Jager et. al. (2011) *Financing Renewable Energy in the European Energy Market*. Utrecht, the Netherlands: Ecofys, Fraunhofer ISI, TU Vienna EEG and Ernst & Young.

7 Deutsche Bank Climate Change Advisors (2011) *UK Offshore Wind: Opportunity, Cost and Financing.* London, UK and New York, NY, USA: DB Group Rabobank and BNEF (2011) *Offshore Wind: Foundations for Growth.* Utrecht, the Netherlands: Rabobank International. Rubel et al. (2013) *EU 2020 Offshore-Wind Targets. The € 110 Billion Financing Challenge.* Frankfurt, Germany: The Boston Consulting Group.

8 KfW Bankengruppe (2011) *Information Sheet on KfW Offshore Wind Energy Programme.* Frankfurt, Germany: KfW. Department of Business Innovation and Skills (2011) *Next steps for the Green Investment Bank.* Press notice. [accessed 2014-06-30]

9 Rabobank and BNEF (2011).

10 See Karltorp (2014) Challenges in mobilising financial resources to renewable energy, submitted for publication, for further details and references.

risk-return ratio. However, the introduction of a policy can also lead to a political risk.[11]

The first challenge is that the hitherto main source of finance (balance sheet funding at utilities) will not be sufficient as utilities have an increasing number of farms planned in parallel with other investments to fund. External investors must, therefore, provide the needed capital.

Second, the financial crisis has caused a reduction of the liquidity in the market for project finance, i.e. funding where only the project itself is used as safety for the loan. Thus, it now takes more banks to do project finance (as each bank can provide a smaller part of the total investment), which increases complexity and cost. In addition, the introduction of a new piece of legislation, Basel III, with a stricter regulation of the capital-asset ratio, may further reduce the availability of debt. As a result, access to capital is reduced and the time horizon for this type of finance may be decreased from up to 15 to 7-8 years, implying that borrowers might have to seek finance several times during a project's lifetime. Thus, even though project finance has been a way to fund offshore wind, it is not likely it can match the financial resources needed for a large-scale deployment of offshore wind.

Third, many external investors associate offshore wind with large risks (and low returns) and therefore hesitate to invest. Even though there are numerous offshore wind plants in operation, there are still technological risks and as wind farms move further from shore and into deeper waters there are new technical challenges with e.g. grid connection and construction of foundations.[12] The complexity of constructing an offshore wind farm and the large number of contractors usually involved also cause construction risk. O&M risk is a result of the fact that the industry is young and knowledge of operation, maintenance and deconstruction at the end of the turbines lifetime is still weak. Market risk and political risk vary from one country to another.

In addition, the construction of an offshore wind farm is very costly, both in terms of the total cost and cost per unit of output. Total cost of an offshore wind farm typically amount to 1-1.5 EUR billion (in 2012, the average size of a farm was 130 MW).[13] The cost of the electricity generated is in the range 0.06 – 0.18 EUR/kWh, which can be compared to the cost of onshore wind power of 0.05- 0.09 EUR/kWh.[14] The returns, and the possibility to make profit from a project is, therefore, very much dependent on policy intervention. Examples of strong market supporting policies are found in the UK and Germany, while the opposite prevails in the Netherlands and Sweden.[15] The third challenge is that without strong policy support,

11 Wüstenhagen, R. and Menichetti, E. (2012) Strategic choices for renewable energy investment: Conceptual framework and opportunities for further research. *Energy Policy* 40:1-10; Mitchell, C. et al. (2006) Effectiveness through risk reduction: a comparison of the renewable obligation in England and Wales and the feed-in system in Germany. *Energy Policy* 34:297-305.
12 De Decker, J. et. al. (2011) *OffshoreGrid: Offshore Electricity Infrastructure in Europe.* Brussels, Belgium: OffshoreGrid; Kaldellis, J. K. and Kapsali, M. (2013) Shifting towards offshore wind energy-Recent activity and future development. *Energy Policy* 53:136-148.
13 KPMG (2010) *Offshore Wind in Europe - 2010 Market Report.* Berlin, Germany: KPMG AG; EWEA (2013) *The European offshore wind industry - key trends and statistics 2012.* Brussels, Belgium: EWEA.
14 Rabobank (2011) Reaching EUR 10c/KWh… 10 ways to cut subsidies in offshore wind.; Kaldellis, J. K. and Kapsali, M. (2013) Shifting towards offshore wind energy-Recent activity and future development. *Energy Policy* 53:136-148.
15 Söderholm, P. and Pettersson, M. (2011) Offshore wind power policy and planning in Sweden. *Energy Policy* 39:518-525.

offshore wind power is an investment with not only high risk but also with low returns, which implies that significant political and market risks exist for offshore investments, in particular as these have a life-time of 20-25 years.

Fourth, venture capitalists are the type of investors that take high risk. However, the size of investment needed and the long life-time of an offshore wind project do not fit well with the investment model of venture capitalists. Typically, these investors prefer investments with high risk and high return and a relatively short time horizon.

Fifth, institutional investors manage assets in the magnitude required for offshore wind farms and could provide the financial resources needed. However, these investors normally do not take high risk and are not used to invest directly in projects with emerging technologies. An exception is the Danish utility Dong which has managed to get institutional investors involved by employing an innovative business model, where Dong sells parts of offshore wind farms, but still takes the construction risk. The challenge is, therefore, to reduce risk and stimulate investments from institutional investors that are not used to invest directly in assets such as offshore wind.

Finally, in the last decades the financial sector has engaged in a great deal of speculation focussing on short-term, high risk investments with great profit potentials. This might be interpreted as a general lack of interest in typical utility projects with long-term project funding, high risk and low rates of return.[16]

HOW TO MOBILISE FINANCIAL RESOURCES

Policy makers can improve the risk-return ratios by introducing support systems such as the feed-in-tariffs operating in Germany which reduces market risks and improves returns. It is important that such measures are stable and developed in a transparent process in order to limit the political risk. At the same time, an important way forward for the industry is to reduce cost in order to increase the return. This will also make offshore wind power projects less dependent on support systems.[17]

As the offshore wind power industry becomes more mature (and associated with less risk) new actors, such as institutional investors, might be willing to invest. In the meantime, one way forward is to strengthen the lending and risk-absorption capacity of public investment banks. The European Investment Bank and KfW in Germany provide successful examples of this.

Another way is to set up bonds with the specific purpose to finance renewable energy technology.[18] For example, a bank could set up a "Climate Bond" on the bond market and associated capital would only be allowed for financing of

16 Jacobsson, R. and Jacobsson, S. (2012) The emerging funding gap for the European Energy Sector – will the financial sector deliver? *Environmental Innovations and Sustainable Transitions* 5:49-59.

17 The recent development in the solar PV industry illustrates this effect. A history of subsidised markets has enabled cost reductions through learning and economies of scale. In 2014, this cost reduction has made PV expansion partially independent of government support on several markets.

18 Mathews, J. A. et al. (2010) Mobilizing private finance to drive an energy industrial revolution. *Energy Policy* 38:3263-3265.

climate-friendly projects. A state or municipality could reduce risks by acting as a guarantor and committing to buy electricity generated from the projects. Such bonds may attract not only institutional investors that wish to invest in climate-friendly project, but cannot invest in these types of projects directly, but also other sources of capital, such as private individuals.

As the risk linked to an emerging technology might be perceived as higher than it actually is, technology developers may benefit from educating investors. This would enable potential investors to more accurately evaluate the specific risks linked to an investment opportunity in e.g. offshore wind. Another solution is that the investors themselves acquire the needed competence, e.g. through recruiting senior staff from the offshore wind industry.

Technology developers can also introduce business models with novel ways of sharing risks in order to attract investors that otherwise would hesitate due to too high risks. For example, if the technology developers absorb some of the technology and construction risks it may be possible to involve institutional investors on a larger scale. As mentioned above, an example of this is Dong's collaboration with Danish pension funds.

A summary of the challenges of mobilising financial resources to offshore wind and the suggestions of how to overcome these are presented in Figure 16.2.

HUMAN RESOURCES

An adequate supply of human resources is another critical factor for the development and deployment of offshore wind farms.[19] By 2030, European Wind Energy Association estimates that almost 300 000 will be employed in the offshore wind energy industry, up from 35 000 today. There is already a shortage of staff. For example, manufacturers of turbines report shortages of engineers, operation and maintenance staff and on-site managers.[20] In this section, the need for human resources is illustrated by the need for engineering competences. This is a key area of competence for the development of the offshore wind industry but, of course, not the only type of competences needed.

It is vital to supply the needed human resources both in terms of numbers and types of competences. An analysis of the number of engineers needed suggests that about 10 000 additional staff may be required in Europe until 2020.[21] The main part of these engineers is needed by turbine manufactures, but also utilities and other parts of the supply chain require many engineers.

Scrutinising the types of competences needed, the main bottleneck is a shortage

19 The case of the emergence and growth of an electronics industry demonstrates the significance of the challenge in that there was a poor responsiveness of the Swedish higher educational sector to growing technological opportunities, at least compared to the US. Indeed, for some years, the number of graduated engineers per capita in the US was over three times that in Sweden. Of course, Swedish industry suffered from lack of competences for many years. Jacobsson, S., et al. (2001) Alternative specifications of the institutional constraint to economic growth - or why is there a shortage of computer and electronic engineers and scientists in Sweden? *Technology Analysis and Strategic Management* 13(2):179-193.

20 EWEA (2011) *Pure Power - Wind energy targets for 2020 and 2030.* Brussels, Belgium: EWEA.; EWEA (2011) *Wind in our sails - The coming of Europe's offshore wind energy industry.* Brussels, Belgium: EWEA.

21 See Jacobsson, S. and Karltorp, K. (2012) Formation of competences to realize the potential of offshore wind power in the European Union. *Energy Policy* 44:374-384, for further details and references related to this section.

of electrical engineers. These are required to strengthen the onshore grid, build an offshore grid and facilitate a large-scale integration of wind power into the power system. They are also needed by turbine manufacturer and some component suppliers. Specialised engineering competences are also needed in mechanical engineering, engineering physics, software engineering and civil engineering.

There is also a need for engineers who integrate hitherto distinct knowledge fields, e.g. electrical and mechanical engineering for the design of turbines. Hence, there is a demand for engineers who understand wind turbines as a whole, including e.g. aerodynamics, lightweight constructions and gearboxes and have the ability to optimize designs, bearing in mind the various loads. Engineers with this integrative competence are currently few, work as product development managers and have developed their competence on the job.

Other examples are engineers with competence in non-engineering fields, such as meteorology and project management. Indeed, project managers constitute a major bottleneck. An engineering background may be suitable for project managers, but they also require knowledge of logistics, finance, risk management and communication as well as an understanding of certification bodies, approval processes and insurance. In addition, health, safety and environmental impact are important knowledge fields for staff working offshore.

There is also a need for more PhDs as some tasks requires deep specialist competence. A case in point is the design and construction of offshore grids where more specialists in HVDC are required. The company Vattenfall alone may require 20-25 PhDs, staff that is not available today.

THE EDUCATION SYSTEM TODAY

Measures have been taken to address some of the current and anticipated shortages. Denmark, with a leading position in the wind turbine industry, has MSc and PhD programs dedicated to wind energy at both Aalborg University and Danish Technical University (DTU). Wind energy education for professionals is offered by Danish University Wind Energy Training and by DTU.[22] Germany has created MSc programs in Bremerhaven, Flensburg, Hannover and Oldenburg. Training for professionals is offered by ForWind and Education Centre for Renewable Energies. PhD training is conducted at several universities and institutes, such as IWES. Another centre for training and education is TU Delft in the Netherlands. As from 2012, it offers a European Wind Energy MSc in collaboration with DTU, the Carl von Ossietzky University of Oldenburg and the Norwegian University of Science and Technology (TU Delft 2012).[23]

In the UK, the measures are more recent and there are shortages of engineers to offshore wind power. Funding has been made available for an Industrial Doctorate Centre to help develop the skills for accelerating offshore renewable technologies – all in all 50 PhDs are to be trained. While several universities offer MSc programs in renewable energy, only the Wind Energy Engineering MSc program

22 Danish University Wind Energy Training (2011).
23 TU Delft (2012) European Wind Energy Masters.

at the University of Central Lancashire is specialised in wind power.[24] Training for professionals is, however, given by Northumberland College and a "renewable energy centre at the Grimsby Institute is to become the first of its kind in the world to train the next generation of offshore engineers". Finally, RenewableUK designed and set up an apprenticeship program supported by industry and handed it over to National Skills Academy.

HOW TO MOBILISE HUMAN RESOURCES

To overcome the current shortage of competences, industry recruits staff from a range of related industries, i.e. industries with overlapping knowledge bases. For instance, aerodynamic engineers may be recruited from the automobile industry to work with wind farm design and material science specialists (for blade design and construction) from the shipbuilding industry. Yet, as industry expands, the particular needs of the offshore wind energy industry should be reflected in the programs and curricula at the universities. As described above, there are some programs that address this need, e.g. in Copenhagen, Delft, Oldenburg and Aalborg. These pioneering programs have to be supplemented with many others if industry is not to suffer unduly from a shortage of competences over the next decades.

First, more programs for developing deep competences, such as in electrical and mechanical engineering, are required. Second, there is a need for broad programs, integrating different engineering competences. A particularly challenging task is to integrate electrical and mechanical engineering. Neither in Denmark, nor in Germany do such programs exist at the MSc level at universities. There is also a need for programs that combine engineering competences with competences from other disciplines. In particular, programs in project management are needed.

With a few exceptions (e.g. DTU and Risö in Copenhagen), universities may not have a research base which is large enough to offer many types of specialisation. Offering a broad MSc program as well as many options for gaining deeper competence in selective fields may, therefore, be limited to the larger universities with a long engagement in wind power research. This raises the possibility of organising a European portfolio of specialised courses that are organisationally integrated and made easily available to students from universities taking part in the program. As mentioned above, a program of this type has started at TU Delft together with three other universities, but this program could be complemented by more initiatives. In addition to setting up programs, it is important to work with increasing the interest of young people in studying engineering and for securing an interest in offshore wind programmes among these.

Expanding the number and types of programs requires the teaching staff to be enlarged. With a time lag of some years, this can be achieved by increasing the number of PhDs, which necessitates an associated expansion in government R&D funding. Enlarged PhD programs are also needed to develop the human capital required to manage the complexity of many of the tasks facing the industry, e.g. in the design of offshore grids. However, in order for universities to adjust programs

24 Cordes, J. (2012) Where to go for wind power qualifications. *Windpower monthly.* Jan. 1 [accessed 2014-07-02].

and curricula according to the needs of industry, it is essential that industry expresses its need for competences. This can be facilitated by joint projects and the formation of strong networks between industry and academia.

CONCLUDING REMARKS

To mitigate climate change, renewable energy technologies must be deployed on a large scale. Achieving this requires technical development as well as non-technical changes, including adjustments within the financial and educational sectors. This chapter has discussed a range of challenges with securing financial and human resources needed for development and deployment of offshore wind power in Europe. A summary of the challenges and some suggestions of how to overcome these are presented in Figure 16.2.

Resource challenges to reach 40 GW offshore wind power in EU 2020

Financial resources – Challenges

- Need for financial resources, as utilities cannot finance to same extent as before and project finance market is limited
- High risk and high cost/low return
- Venture capitalists invest in high risk, but cannot invest in the large size or for the long time needed
- Institutional investors could be an option, but not used to invest directly in emerging technology
- Speculation on the financial market

Suggestions for solutions:

- Increase risk-absorption capacity of public investment banks
- Technology development to reduce cost
- Policy support
- “Renewable energy bonds”
- New business models
- Increase knowledge of renewable energy at investors

Human resources – Challenges

- Need for engineers with specialist competence, particularly in electrical engineering
- Need for integrated competences, both different engineering fields and non-engineering competences (e.g. project management)
- PhDs competence needed to solve complex tasks
- Time lag for development of new competences
- Industry need to express their need of human resources

Suggestions for solutions:

- Programs for developing deep competences
- Programs for developing integrated competences
- Increased coordination between European universities
- Increased number of PhDs
- Industry – academy collaboration

Figure 16.2 Challenges related to the mobilisation of financial and human resources required for reaching the 2020 targets for offshore wind in EU and some suggestions how these challenges could be overcome.

The challenges to mobilising financial resources is that sizable investments are needed at the same time as offshore wind is still linked to high risk and low returns. Policy measures to improve the risk-return ratio and to strengthen the capacity of public investment banks are two ways forward. Institutional investors have access to huge amounts of capital but these investors are not used to invest directly in emerging technology projects. Renewable energy bond may open up that source of capital as may increasing institutional investors' knowledge of offshore wind power and providing new business models where risk is shared between utilities and external investors.

To address the large need for engineering resources, both specialist and integrated programs are needed. PhD competence is needed to solve complex tasks and to supply teachers to these programs. Increased coordination between European universities can be a mean to increase the possibility for engineers to specialise within wind power. Collaboration between industry and academy is important to correctly address the need for competences and to limit the time lag in supplying these competences.

In this chapter the case of offshore wind power has been used to illustrate the challenges of mobilising financial and human resources. We have demonstrated that knowledge of the industry in question is required to understand the specifics of the challenges, e.g. the types of competences that universities need to develop. As many other renewable energy technologies have similar characteristics as offshore wind, e.g. high risk, a long project life-time and the need for new competences that combine knowledge fields in novel ways, they are likely to face similar challenges. Moreover, development of several technologies in parallel will multiply the demands on the financial and educational sectors. We would, therefore, argue that this kind of analysis need to be multiplied in order for us to be able to design appropriate policies that support a large scale transformation of the energy sector.