KAPSARC Energy Workshop Series

مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

Energy transitions policy: What matters most

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is an independent, non-profit research institution dedicated to researching energy economics, policy, technology, and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

Legal notice

Summary for policymakers

KAPSARC's research into energy transitions asks why transitions take longer and cost more than policymakers anticipate. Our focus is on the dynamics of the supply chains supporting new fuels and technologies as they penetrate sectors previously occupied by fossil fuels. In this brief, we build on two previous workshops that:

- Proposed a framework for analyzing competitive interactions between different technologies and fuels
- Categorized competitive influences, including trade policy and power market design.

This workshop considered the benefits of a less confrontational approach to energy transitions, by discussing the relationship between conventionals and renewables, than is being witnessed in many OECD countries – a win/win rather than a win/lose paradigm. Governments create challenges with "blanket" policies that are meant to deliver multiple objectives that include energy security, economic prosperity, green jobs, industrial development, and mitigate climate change all at the same time. The result is a set of unfulfilled expectations about the role renewables can play in the energy economy. If policymakers define the objective and role of renewable energies more narrowly, they will be better able to create the appropriate environment for these goals to be achieved.

Currently, renewable technologies are not viable without conventional energy as back up. This is a reason why governments should promote transitions policies that maximize economic efficiency by exploiting synergies between renewable and conventional energies, to capitalize on their respective strengths. These transitions policies can change the current paradigm of renewable and conventional energies from being viewed as foes to becoming—perhaps, even—friends.

This does not mean that governments should stop supporting research and development (R&D), enhancing grid connectivity, and pursuing effective storage capabilities to mitigate the costs of renewables. Developments such as these, coupled with innovative financing alternatives, can reduce the costs of renewable energies, thereby increasing their competitiveness and desirability even to the skeptics.

Historical transitions have seen augmentation of the supply and demand for many of the fuels used today. More biomass, coal, oil, and gas are consumed than ever before. Existing fuels tend to migrate to their highest value niches as new fuels and technologies displace them in sectors previously occupied by fossil fuels. Policies that interfere with this natural evolutionary process will likely cost more and achieve less than those that reflect the working of markets and innovation.

Background to the workshop

KAPSARC's October 2014 Energy Transitions Workshop in Riyadh built on two previous workshops held in May 2014 and November 2013. The first workshop discussed the conceptual framework of power technology transitions and the interactions between renewables and conventionals (See workshop policy brief: *A Framework for Fuel and Technology Transitions in Energy: Evaluating Policy Effectiveness*). The second workshop focused on "one-size-fits-all" blanket policies for renewables that have not delivered optimal results as they do not take into consideration the spillovers between political, social, and economic spheres (See workshop policy brief: *Policy Support for Energy Transitions: Where is Public Money Best Spent*?).

Some 30 global renewable energy and transitions policy experts from industry, government, and academia offered their perspectives on the effectiveness of bundling policies to achieve renewable objectives. Discussions also focused on competition between new and incumbent technologies, and how policy may achieve better outcome in an environment of coexistence instead of tension.

Renewable energy policy generally aspires to accelerate fuel and technology transitions, while simultaneously supporting the development of local technology manufacturing and service sectors. Financial and non-financial policy instruments are designed with the stated aim of achieving transition objectives in a fast-paced, cost-effective manner.

Recent experiences suggest that balancing the desired transition pace with national supply-chain development aspirations represents a challenge for policy design. In some cases, commonly used incentives to generate "demand-pull" for renewable energy have raised demand for the new technology faster than the ability of local supply chains to respond. In other instances, supply-push policy instruments have caused renewable technology supply surpluses beyond the local (and even global) market's ability to absorb them. Furthermore, incumbent fuel and technology supply chains are likely to capitalize on decades-long innovation and investment efforts and continue to improve their competitiveness.

Policy aimed at stimulating transitions generates a number of complex new dynamics, especially when these policies are subject to frequent changes of administration and announced policy targets. In particular, efforts of the economic players to comply are less efficient when faced with moving targets and unexpected interactions between different policies. These complexities and uncertainties can vary between countries and regions. KAPSARC's research aims to establish a framework for discussion to facilitate creative and effective policy design that incorporates the major dynamics likely to arise.

Renewables vs conventionals: Friends or foes?

The question of whether renewable and conventional technologies are friends or foes has no simple global answer. It depends on when and where this question is asked, as well as the readiness of governments to accept friendly coexistence. Technological, political, geographical, and market factors play a role in shaping the relationship between renewables and conventionals. However, and for the time being, conventional fuels are the most effective way to ameliorate the cost of the intermittency of wind and solar energies. The intermittency of renewable technologies positions conventional and renewable energies as friends.

Given the intermittency of renewables, and absent cost-effective storage solutions, it will be generally easier for renewables to secure a place in the energy mix of a country if their generation profile matches the load profile of that country. By contrast, if the peak of generation of renewable energy takes place when demand for energy is minimum, the integration of renewables in the grid is more complex.

Another dimension that could shape the relationship between conventional and renewable energy is the level of connectivity of a grid with other regions or countries. In principle, regions with high levels of grid interconnectivity and effective demand management – i.e. regions that can easily export or import electricity – can manage the integration of renewable energy more efficiently.

Smart grids, storage, and demand management are currently fertile areas for research to overcome the challenges of intermittency. In a bolder and more ambitious future, some policymakers claim that conventional energy may not be required at all as a result of the deployment of a mosaic of renewable technologies. This positions renewables as a mortal foe – a threat to the existence of fossil-fuel-based businesses. It can hardly be a surprise to see the latter's response in seeking a secure future for conventional energy resources.

> **"[The energy mix] is a bit like a national football team – players compete for their clubs to win selection but then play as a team once selected for the national team."**

Prevailing electricity prices play a significant role in shaping the relationship between renewables and conventionals. In markets dominated by cheap conventional energies – especially in developing countries where electricity prices may be subsidized – government intervention is required to support the business case for investing in renewables and to overcome the lack of cost competitiveness.

Model representations of transitions

Reducing reliance on conventional energy and creating an energy mix that includes renewables as a key element requires time, effort, funds, and planning. In this context, modeling presents itself as a natural route to study how the future may evolve. Models, whether in the social or physical sciences, can be used as a cost-effective test bench for different scenarios in generating insight and advice for policymakers and other interested parties.

Traditionally, energy transitions have been modeled on a range of approaches including system dynamics, computable general equilibrium, and optimization modeling (mostly linear programming). These methods share a common feature: they are all top-down approaches that may overlook the interactions between the micro and macro levels within the overall problem. Further, they embed a static causality structure that is predetermined at the early stages of the model formulation. As a result, such modeling tools do not properly represent a complex adaptive system, such as the one present in energy transitions, where there are varying aggregation and interaction levels between the players.

An alternative and more suitable route is to use a bottom-up modeling approach, like Agent-Based Modeling (ABM), which has been gaining popularity because of its ability to overcome some of the identified limitations. In ABM, the properties of an entire system evolve at multiple levels: a change in the system rules results in individual agents – at the bottom level – altering their behavior to adapt to that change. This ultimately results in a change in the system state.

Agents can be defined using economic theory, which enables rapid formulation of agents, or an agent's behavior can be defined solely by observed data. In this latter case, data may be scarce and, even with the availability of data, the resulting model may struggle to provide results that are more reliable than those based on economic theory.

ABM can yield insights that are difficult to replicate using other methods, sometimes revealing unpredictable behaviors of the agents. A system can be disrupted with sudden policy changes, providing insight from the way the agents react and how the overall system evolves.

However, there are some disadvantages to using ABM. In addition to an initial lack of information as to which agents will be most influential in the model and complexity that may only be identifiable as unnecessary with hindsight, the use of ABM in economics is relatively immature and poorly-accepted by mainstream economists. There are issues of ABM model validation and replicability that may, to some extent, offset the additional flexibility in describing complex problems, including energy transitions.

The industry and market behind renewables

The rate of deployment of renewable technologies depends on multiple factors. However, governmental intervention and public support play a critical role. In general terms, it appears that high levels of public support leads to high penetration of renewables. This is the case of some European countries, including Germany and Spain. However, it has become clear that a high penetration of renewables results in higher costs for electricity consumers, due to the cost of these policies. In addition, renewables impact the wholesale electricity market. As a result, wholesale prices tend to be more volatile, increasing risks in investment decisions. To offset these negative impacts, markets are typically more heavily regulated to accommodate higher penetrations of renewables.

“Policies need to become more economically efficient if they are to deploy renewables on a scale big enough to matter environmentally”

Governmental support for local renewables industries and supply chains is a double-edged sword. On the one hand, supporting local industries can be claimed to serve economic and security-of-supply objectives, especially for an industry poised for long-term growth. However, importing from mature foreign companies may access lower system costs, especially if such companies enjoy additional scale-economy cost reduction opportunities and more efficient management of their working capital. There is no conclusive evidence that strong public support for renewables results in a competitive local industry. Some countries provide strong support to renewable energy and have a prosperous renewable energy industry. However, the solar industry in Europe provides an example of the opposite.

"As technology cost reduction opportunities are becoming more difficult, innovative financing solutions present a good opportunity for further cost cuts."

According to some participants, the renewables sector is finding it harder to drive costs down in the short term. In the past few years, incremental innovations have led to decreases in the equivalent costs of renewable power. However, more recently, it seems that solar PV and wind technologies have reached a level of maturity that makes further technology-driven cost reductions difficult in the near term. In the absence of incremental technology advancement, perhaps innovative financing solutions offer the best hope for the next tranche of renewable electricity cost reductions.

What matters most in policy

It is axiomatic that a successful and sustainable transition to renewables is more likely with a well-designed policy. However, the term "well-designed" is loose and triggers controversy on what distinguishes a good policy from a better one. Politicians tend to sell renewables to the public as a way of achieving many objectives at the same time. Such objectives include creating new jobs via a local – but globally competitive – manufacturing industry, reducing carbon emissions, and reducing energy imports (in the form of coal, oil, gas, etc.). In reality, it is virtually impossible to achieve these objectives simultaneously.

> **"The lack of clarity of goals often leads to [bad] policies"**

Stability of renewable policies is as important as the clarity of their objectives to their success. Investors and firms prefer dealing with business risk rather than with regulatory risk, especially where success of that renewables project depends heavily on governmental support. Investors evaluate not only the profitability of a project, but also the long run sustainability of policy support, preferring to avoid countries where renewables policies are frequently altered.

The current quest for renewable energy transitions is relatively young. Most countries, if not all of them, are learning-by-doing and this explains why the global deployment of renewables has not been always economically efficient. The conundrum for policymakers is that, faced with rapid evolution of renewables industries and the pace of technology developments, investors crave policy stability. However, for a policy to be effective, it has to reflect this ever-changing global competitive landscape.

Conclusion

Governments have not been successful in addressing energy security, economic prosperity, job creation, industrial development, and climate change under a single umbrella policy. Policymakers are likely to achieve greater success if they define clearly the role of renewables and design policies limited to that defined role. In addition, identifying clear objectives for renewables that reflect a country's specific needs may achieve better results than applying a generic, universal solution.

Renewables, in their current state, cannot exist without the support of conventionals. For the time being, renewables and conventionals are collaborators in the development of a more-diversified energy mix for the future. A less confrontational approach to policy, overcoming the fear that accommodating conventionals in any form will undermine the transition objective, will provide a more economically efficient solution to meeting a country's need for secure, sustainable and affordable energy. As important as the design of renewable policies is, the stability of those policies is essential to attract investors. Such stability is more likely if renewable and conventional energy are viewed as partners rather than adversaries.

About the workshop

KAPSARC convened its third Energy Transitions workshop in October 2014, with some 30 international experts, to facilitate a dialogue on the progress of the framework we are developing at KAPSARC for understanding fuel and technology transitions. Participants included:

Samer AlAshgar – President, KAPSARC

Shahad Albardi – Research Analyst, KAPSARC

Jeffrey Ball – Scholar-in-Residence, Stanford University

Patrick Bean – Senior Research Associate, KAPSARC

Raed Bkayrat – Director of Business Development, First Solar LLZ

Jorge Blazquez – Research Fellow, KAPSARC

Mohammed Al-Bugami – Senior Vice President of Operations, Advanced Electronic Company

Suleyman Bulut – Analyst, International Energy Agency

Marcello Contestabile – Research Fellow, KAPSARC

Kankana Dubey – Research Associate, KAPSARC

Amro Elshurafa – Senior Research Associate, KAPSARC

Tareq Emtairah – Executive Director, Regional Center for Renewable Energy and Energy Efficiency (RCREEE)

Daniel Fuerstenwerth – Senior Analyst, Agora Energiewende

Chris Gotch – First Secretary, British Embassy in Saudi Arabia

Meslet Al-Hajri – Strategy Sector, King Abdullah City for Atomic and Renewable Energy

David Hobbs – Head of Research, KAPSARC

Mohammed Ibrahim – Research & Studies Engineer at General Wind Energy Management, Ministry of Electricity and Energy

Oscar Kraan – Researcher, TU Delft University

Gonzalo Saenz de Miera – Director of Energy Policy, Iberdrola

Jose Martin-Moreno – Professor, Universidad de Vigo

Nora Nezamuddin – Research Analyst, KAPSARC

Saleh Al-Salem – Director of Renewable Energy, Al-Gihaz Holding

Osama Alsayegh – Director, Kuwait Institute of Scientific Research

Sebastian Schwenen – Researcher, DIW Berlin

Alexandra Sombsthay – Policy Officer, European Commission

Telli van der Lei – Assistant Professor, TU Delft University

Jorg Wojahn – Counsellor, European Union-Delegation to the Kingdom of Saudi Arabia

Tamim Zamrik – Research Associate, KAPSARC

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About the team

Shahad AlBardi is a Research Analyst, focusing on renewable energy. She holds a BSc in electrical and computer engineering from Effat University in Jeddah.

Nora Nezamuddin is a Research Analyst focusing on transition policy and technology supply chain. She holds a BA degree from the American University, Washington, DC.

Jorge Blazquez is a Research Fellow specialising in energy and economics. He has a PhD in macroeconomics from Universidad Complutense de Madrid.

Tamim Zamrik is a Research Associate developing a modeling framework for energy transitions and supply chains. He holds a PhD in quantitative finance from Imperial College London.

Amro Elshurafa is a Senior Research Associate working on cost and technology assessments. Credited with 30 papers and 5 patents, he holds a PhD in electrical engineering.

About the fuel and technology transitions project

The goal of this project is to understand how policy can expedite renewable energy transitions in a cost-effective way, while allowing competitive national industries to develop. In line with this objective, a wide range of policy instruments, designed and implemented to promote renewable energy, are being assessed. Furthermore, the project takes a holistic approach by analyzing how the competitive dynamics between renewable technologies and incumbent technologies evolve.

The workshop series, in line with KAPSARC's overall mission, fits into the overall project by providing a space for dialogue, collaboration, feedback on current work, and setting future research directions.