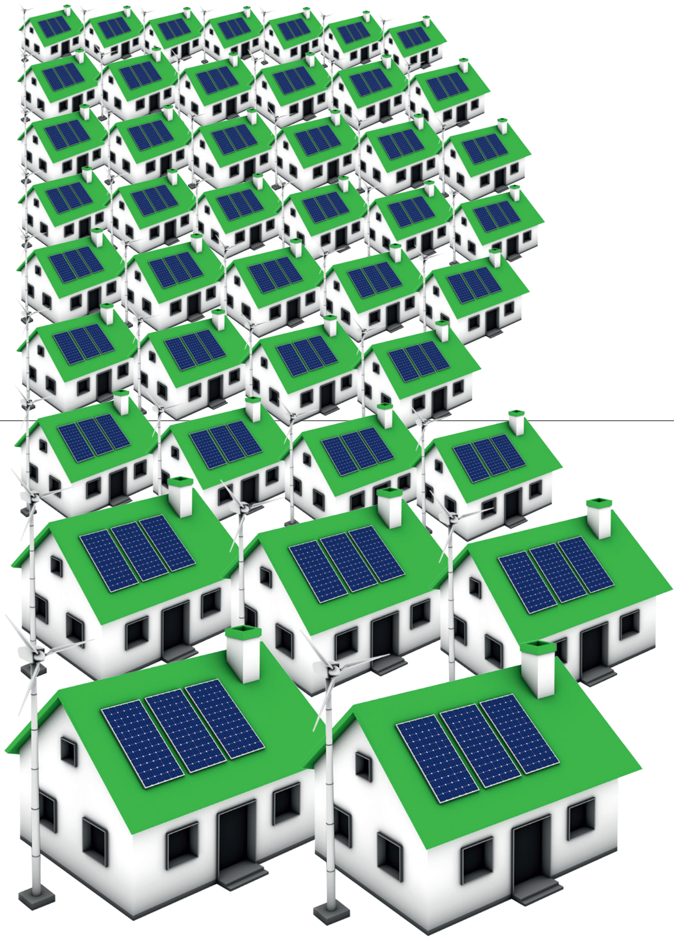
Think:Act

navigating complexity



November 2017

Power to the People

The Future of Europe's Decentralized Energy Market

Roland Berger

50 YEARS navigating complexity

THINKING FORWARD BOLDLY:
4 SCENARIOS FOR DECENTRALIZED ENERGY
→ P. 15

3

-79%

Decline in the global spot price of an average silicon solar module from 2010 to 2017.

Page 7

50

We asked 50 experts to identify and evaluate the most important factors influencing the development of a European decentralized energy system up to 2035.

Page 8

13

We identified 13 Critical Uncertainties that shape four scenarios for the future of decentralized energy in Europe.

Page 10

The development of decentralized energy in Europe is uncertain. We need scenarios to prepare for the future.

The shift from large, centralized power stations to small, localized and greener alternatives is well underway in Europe. But increasing levels of uncertainty in global energy markets make it difficult to predict the future success of these decentralized energy systems. We undertook a study involving input from 50 experts to determine what the European market will look like in 2035. Four scenarios were developed, based on the key political and market variables that the experts thought most likely to affect the transition to decentralized energy systems. These models were used to draw up implications and potential courses of action for policymakers and market players.

RAPID CHANGE

Europe's energy landscape is changing rapidly. Renewable energy sources, such as wind, solar and biomass, are increasingly replacing traditional fossil fuel-based production as European Union members seek to meet the bloc's 2030 energy targets. These aim to cut greenhouse gas emissions by 40% compared to 1990 levels, and ensure renewables are responsible for 27% of energy production. Several countries, including Germany, have national targets over and above those set by the EU.

This shift is also changing the way power is generated and distributed, with a move away from a centralized system based on large power stations to a decentralized model. This is defined as energy generated or stored by small, grid-connected devices close to where it is used, such as by onshore wind, photovoltaic, combined heat and power, geothermal and storage technologies, e.g. batteries. Intermittency of power generation and fluctuations in use mean that decentralized systems require technologies – so-called smart grids – to balance supply and demand. Therefore the development of devices such as large batteries and smart meters is an important prerequisite to build efficient decentralized energy systems.

HIGH POLITICAL COMPLEXITY

Differing national policies and technology strategies mean that it is difficult to predict how quickly decentralized systems will develop in Europe. However, progress is likely to be driven by two key factors: political and market developments.

The political environment is the most complex, with national, European and global dimensions. At a national level, policy changes, such as those to phase out nuclear power in Germany or France's bid to reduce its

Cover photo: mtrommer/GettyImages; p. 4/5: vladwel/iStock

A

THE WAY FORWARD

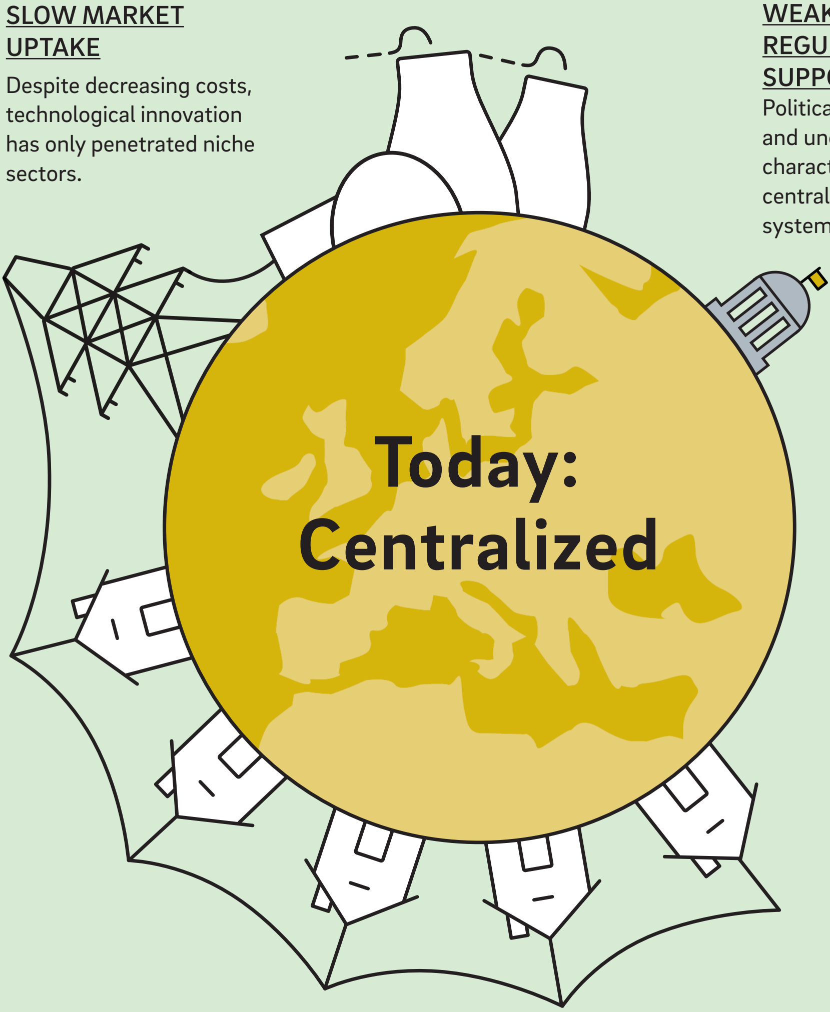
Characteristics of a decentralized energy system

SLOW MARKET UPTAKE

Despite decreasing costs, technological innovation has only penetrated niche sectors.

WEAK REGULATORY SUPPORT

Political complexity and uncertainty characterize today's centralized energy system.

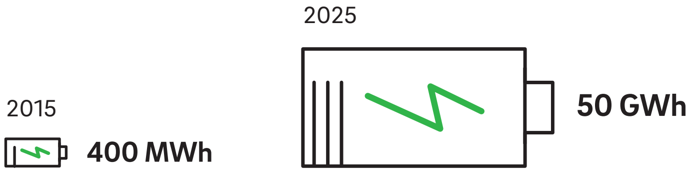


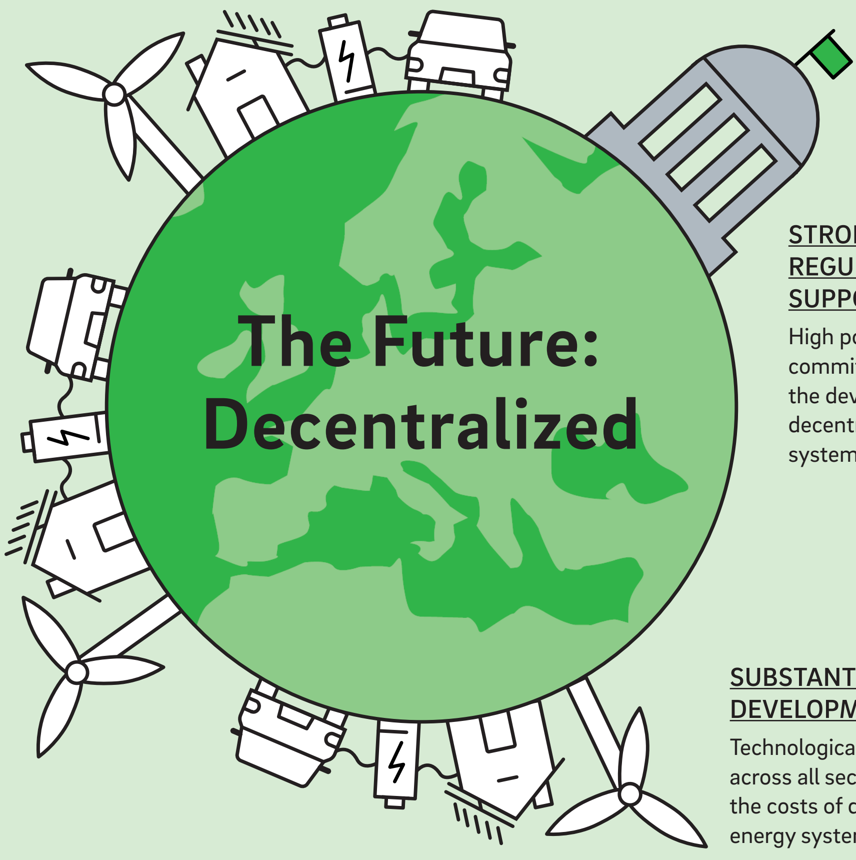
Status quo: A centralized energy system

Low political commitment meets slow market uptake of new technologies, impeding the development of a decentralized energy system.

EVOLUTION OF GLOBALLY INSTALLED BATTERY STORAGE

Battery prices keep falling while technological capabilities increase as a result of constant development. Market studies project a global storage capacity of 50 GWh by 2025 (excluding pumped hydro storage).





STRONG REGULATORY SUPPORT

High political commitment supports the development of a decentralized energy system.

SUBSTANTIAL MARKET DEVELOPMENT

Technological innovation across all sectors decreases the costs of decentralized energy systems.

Best case scenario: A green revolution

High political commitment and strong market development foster a fast transition to a decentralized energy system.

dependence on nuclear-produced electricity from 75% to 50% by 2025, provide opportunities for decentralized systems. But emissions from some EU members, such as Spain, continue to rise, and more government incentives are needed to further establish and spread technologies that support the decentralized energy system. Across Europe, the EU targets loom large, as does the desire of members to increase their energy independence (the bloc currently imports 54% of its energy needs). From a global perspective, the U.N. Climate Change Conference in Paris in 2015 saw countries agree to limit the global temperature rise to less than 2°C. However, the decision by the U.S. to pull out of the agreement calls into question the international consensus on emissions reduction. Meanwhile, China, which along with the EU has affirmed its commitment to the Paris agreement, is making great efforts to decarbonize its economy.

Decentralized energy is defined as energy generated or stored by small, grid-connected devices close to where it is used.

DECREASING COSTS

In the marketplace, the cost of decentralized energy generation has declined considerably in the past few years. For example, the global spot price of an average silicon solar module decreased from EUR 1.33 per watt at the beginning of 2010 to EUR 0.27 at the end of September 2017.[1] → B And in Germany, the price of a typical 10–100 kilowatt peak (a unit of maximum output) photovoltaic rooftop system fell from about EUR 4,700 per kWp in Q4 2006 to 1,270 per kWp in Q4 2016.[2] This has been spurred on by technological developments, incentive schemes and an increase in installed capacity.

A similar development can be seen in energy storage technology. Battery prices keep falling while technological capabilities increase as a result of constant development. Market studies project a global storage capacity of 50 GWh[3], excluding pumped hydro storage, by 2025. This would be enough to run 800,000 average German households for a week. The majority will be based on lithium-ion batteries. In 2015 there was a total capacity of roughly 1% of this amount, or 400 MWh. Combined with demand-response systems and energy efficiency initiatives, large-, medium- and small-scale storage solutions and economically viable photovoltaic and wind systems will be a significant driver for future decentralized power generation.[4]

INCENTIVES AND DISINCENTIVES

Electricity prices and taxes are another important market factor. On the one hand, high electricity prices and taxes encourage consumers to diversify into decentralized energy sources and produce their own electricity, e.g. via a PV rooftop system, as self-made electricity is not normally subject to taxes. But on the other hand, high tax revenues could disincentivize governments from investing in a decentralized energy system. In addition, high electricity prices could increase the level of skepticism about the energy transition: If consumers see that they have to pay a substantial amount to build up the renewable infrastructure, they may question the energy transition or at least the speed of its implementation.

SCENARIO PLANNING NEEDED

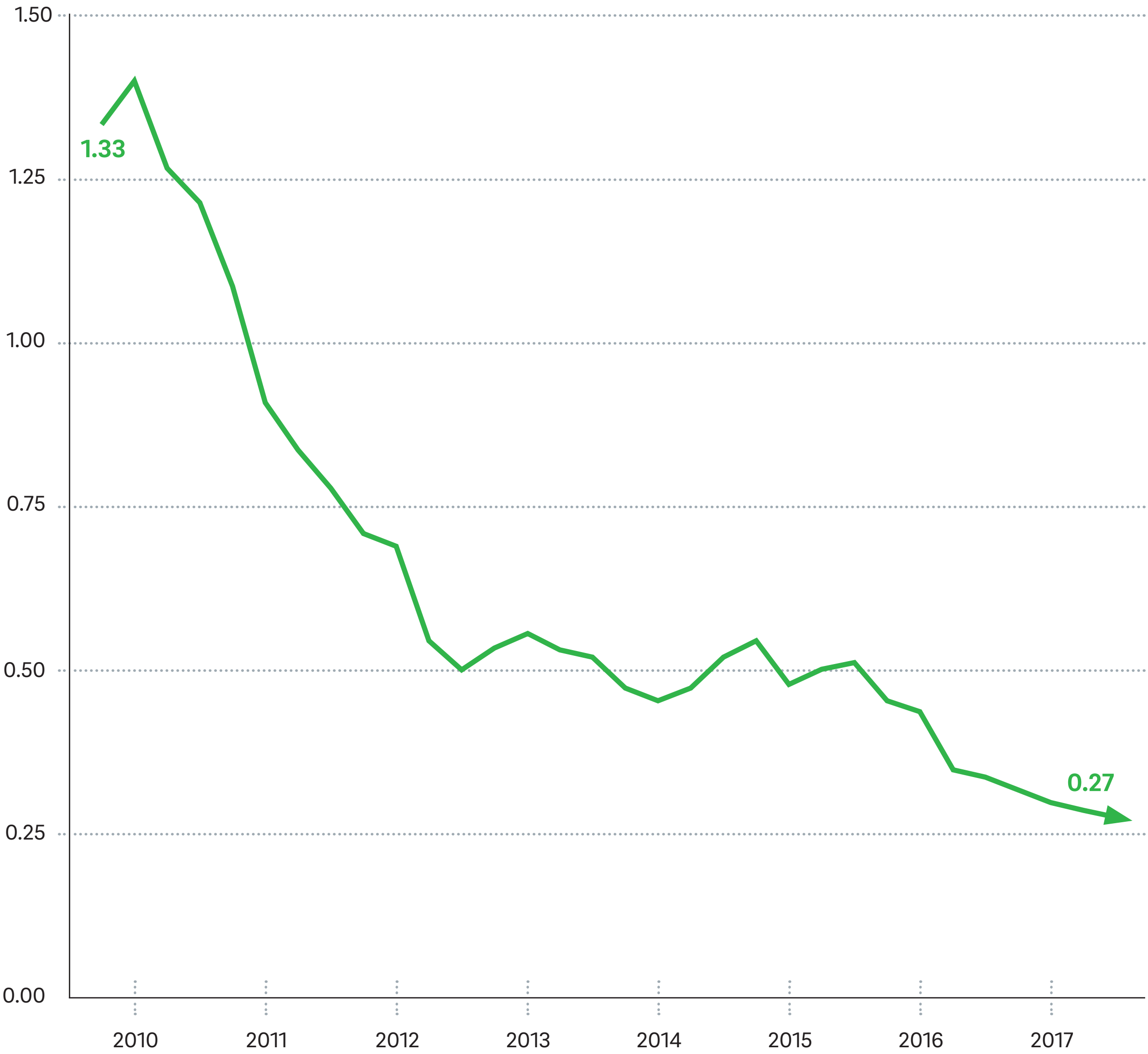
In summary, the development of decentralized energy systems in Europe is difficult to predict. In the past, strong political commitment and high energy prices boosted the transition. However, global events in the past two years have created a more uncertain outlook. To shed light on the issue, we developed four scenarios that illustrate possible directions of travel between now and 2035, and their implications for policymakers and market players.

1 Bloomberg
2 Fraunhofer ISE, Photovoltaics Report 2017
3 WEF, Future of Electricity, 2017
4 For a detailed analysis of energy storage systems see: Business models in energy storage, Roland Berger Focus, May 2017

B

THE GLOBAL SPOT PRICE OF AN AVERAGE SILICON SOLAR MODULE

EUR/watt

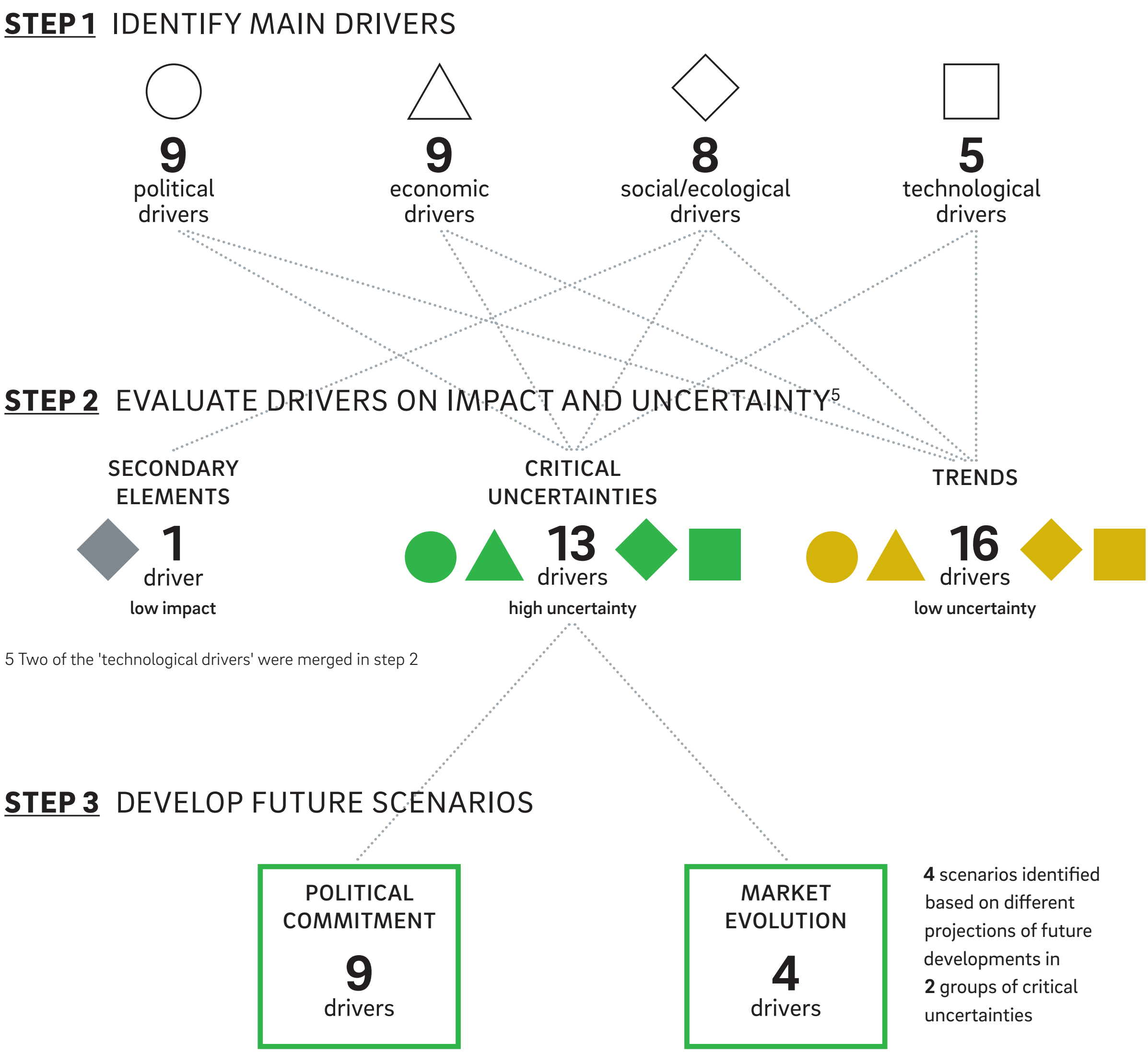


Source: Bloomberg

C

OUR METHODOLOGY TO DEVELOP SCENARIOS IS BASED ON 360° STAKEHOLDER FEEDBACK

Overview of the methodology



5 Two of the 'technological drivers' were merged in step 2

Source: Expert survey, Roland Berger

Experts identified 13 Critical Uncertainties and 16 Trends for the future of decentralized energy in Europe.

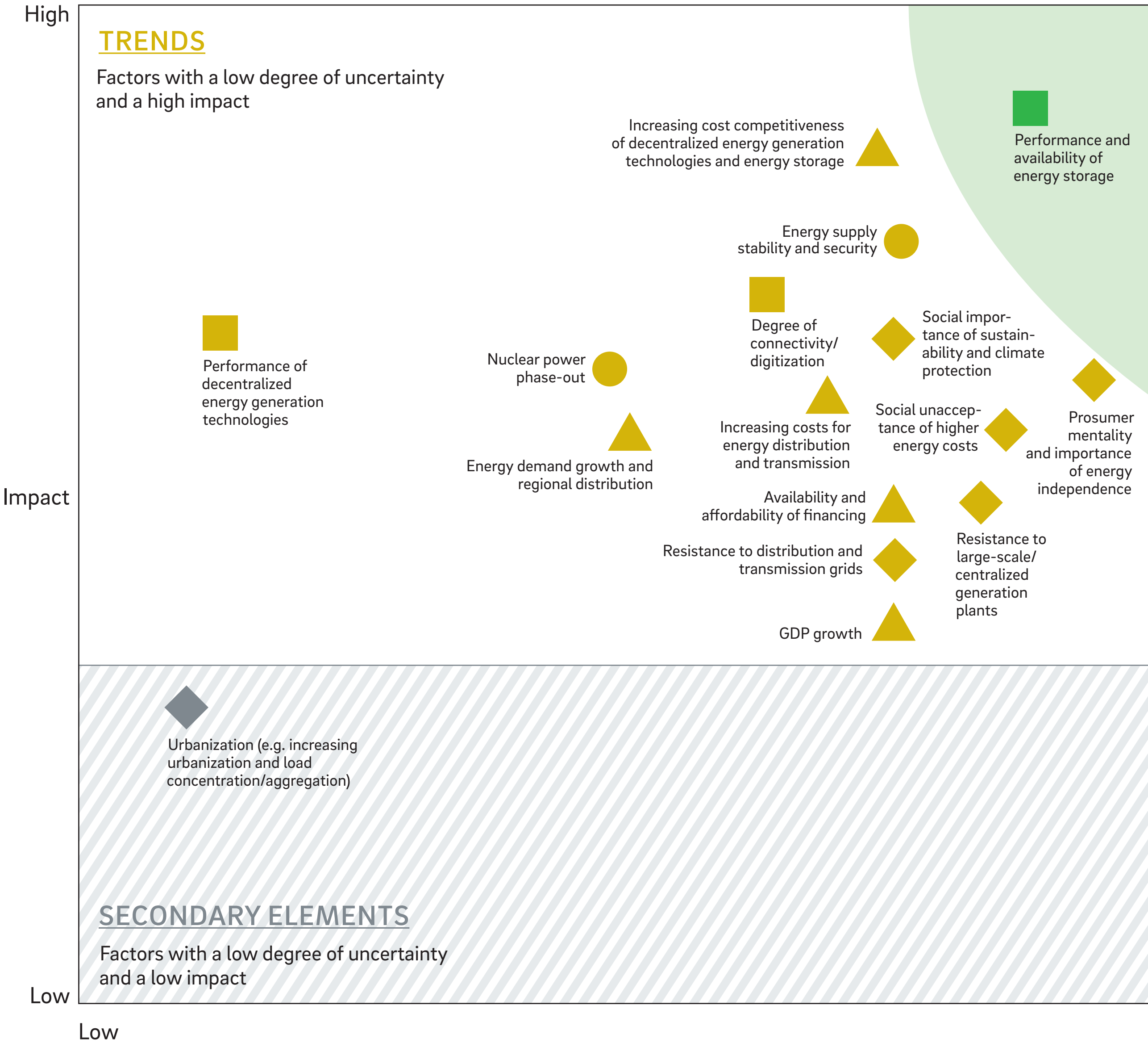
To develop our scenario framework, we combined an analysis of several comprehensive studies with a two-round, 360° stakeholder evaluation involving national and international industry, research and consulting experts on European energy markets.
In the first round, we asked our experts to name factors that will shape the decentralized energy market in major European countries until 2035. The open questionnaire was structured on the basis of five dimensions: political/legal, economic, social, technological and ecological influence factors. We contacted over 200 experts, 50 of whom identified a range of different drivers. These factors were synthesized (i.e. factors with the same meaning but different wording were clustered to one factor) to create a comprehensive list of drivers of the energy transition.
In the second round, we asked our experts to evaluate these drivers according to their potential impact on performance and their degree of uncertainty on a scale from one (low/weak) to ten (high/strong). The results of the second questionnaire were then used to identify those factors with the highest impact. This high-impact group was in turn structured according to the degree of uncertainty in order to derive 'Trends' and 'Critical Uncertainties'. → C

Critical uncertainties are defined as drivers that are likely to have a high impact on the energy transition, but whose actual development and realization are highly uncertain.

D

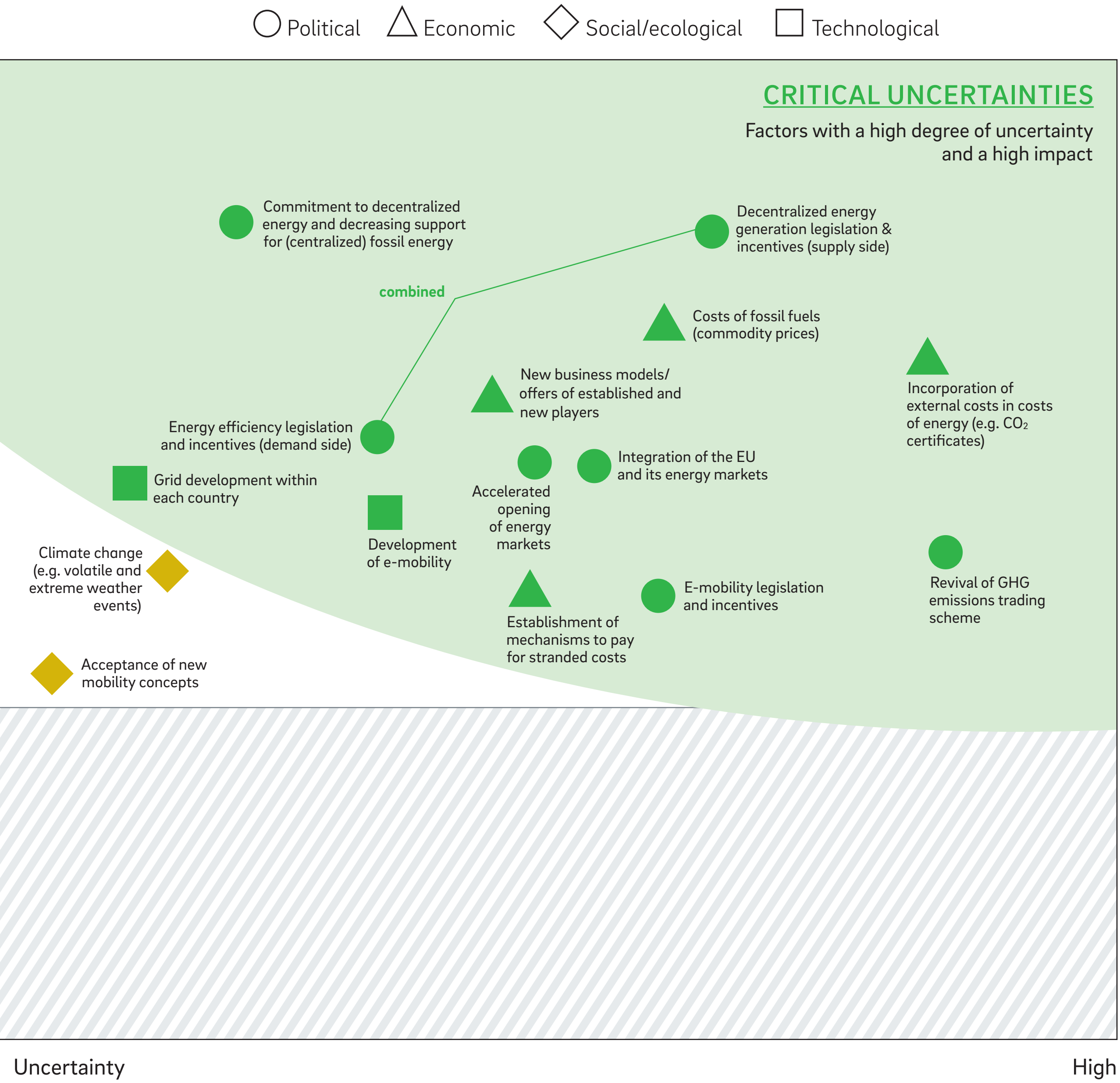
COMPLEX LANDSCAPE

The evolution of decentralized energy in Europe hinges on many factors



Source: Expert survey (360° Stakeholder Feedback)

EXPERTS IDENTIFIED **13 CRITICAL UNCERTAINTIES, 16 TRENDS** AND **1 SECONDARY ELEMENT**



TRENDS AND CRITICAL UNCERTAINTIES

Trends are defined as drivers with a high impact and a high certainty of materializing. This group comprises those drivers on which there is a high level of agreement on their future development among stakeholders. They were therefore incorporated as a common foundation for all four of the scenarios.

In contrast to Trends, which have a similar impact on all future developments, the actual nature of the scenarios was determined by the potential future development and realization of Critical Uncertainties. This group comprises drivers that are likely to have a high impact on the energy transition, but whose actual development and realization is highly uncertain. These better characterize specific scenarios and are therefore used to define them. → D

POLITICAL COMMITMENT AND MARKET EVOLUTION

In order to derive and classify the scenarios for the future of decentralized energy, the Critical Uncertainties were divided into two groups. → E

E

POLITICS AND MARKET

The future of decentralized energy is driven by political factors and the market development

DRIVERS (CRITICAL UNCERTAINTIES) LINKED…

… TO POLITICAL COMMITMENT

> Closer integration of the European Union and its energy markets
> Accelerated opening of energy markets, i.e. removing barriers to entry in EU countries
> Commitment to decentralized energy and decreasing support for (centralized) fossil fuel energy
> Decentralized energy generation legislation and incentives (supply side), and energy efficiency legislation and incentives (demand side)
> Electromobility legislation and incentives
> Revitalization of EU greenhouse gas emissions trading scheme
> Incorporation of external costs in the cost of energy (e.g. EU carbon credits)
> Establishment of mechanisms to pay for stranded costs, i.e. investments in existing infrastructure, relating to the shift from thermal (fossil plus nuclear) to renewable sources
> Power grid development in individual countries

… TO MARKET EVOLUTION

> New business models and offerings from new and established players
> Costs of fossil fuels (commodity prices)
> Performance and availability of energy storage
> Development of electromobility

Four different market scenarios are possible – from Slow moving market to Green revolution.

To derive the scenarios that describe possible evolutions of European energy systems toward a decentralized model, we worked with a matrix that summarizes both trends and critical uncertainties along the two dimensions of market evolution and political commitment. This produced four different market scenarios:

Green revolution (strong market evolution and high political commitment)
Fragmented evolution (strong market evolution and low political commitment)
Market apathy (weak market evolution and high political commitment)
Slow moving market (weak market evolution and low political commitment)

GREEN REVOLUTION

In this scenario, favorable economic and technological conditions will be further enhanced by regulatory support. Revitalization of emissions trading and/or incorporation of external costs via carbon credits will create additional economic incentives for the accelerated development of renewable energies and smart grids. E-mobility legislation and financial incentives will stimulate manufacturers to switch from internal combustion engines to electric versions. Fast growth will attract additional capital, which will translate into higher research and development budgets. More investment in manufacturing assets and research, together with learning effects from growing scale, will further improve the cost base and competitiveness of decentralized energy solutions. General regulatory support coupled with the establishment of mechanisms to pay for stranded costs will spur the process, both incentivizing change and lowering exit barriers for traditional players. In such an environment it would be possible for major shifts to happen without hefty cost implications for stakeholders. Therefore we would expect overarching changes to take place very quickly.

FRAGMENTED EVOLUTION

Here, decentralized energy will have to compete directly with incumbent centralized systems. The degree of penetration will depend on the economic attractiveness of the new models and the degree of retaliation from existing industry. In the absence of strong regulatory support, stakeholders will face significant challenges in developing market-based mechanisms that enable a smooth transformation. Entry barriers for incumbent players will be very high due to incurring fixed costs, so their willingness to take a proactive role in the transformation process will be low. Unless decentralized energy develops a very strong competitive advantage, either through technological development or as a result of high fossil fuel costs, the penetration speed will be rather low. Decentralization will be more fragmented than in the scenario Green revolution. Sectors in which markets are open to competition may find a way to flourish, however. E-mobility, for example, could thrive even if other decentralized energy systems fail to take off. That said, decentralized energy systems in heavily regulated markets will most likely struggle without fundamental support.

The framework may provide guidance on the current status of European countries and indicate the path of their expected future development along the two scenario dimensions.

MARKET APATHY

In this scenario, strong political support will drive higher penetration, but without improvements in market evolution most advances will be temporary and will reverse without public support. There will be a situation where decentralized energy fails to become economically attractive due to poor technological and cost evolution, and/or very low costs of fossil fuels. Regulatory support will ensure some development, but if the decentralized energy market doesn't improve its competitiveness this will be directly dependent on the scale of the artificial support. Furthermore, it will be hard to maintain long-term political backing if decentralized energy is perceived as too costly; any global or local economic shock could trigger resentment or even a total loss of public support.

SLOW MOVING MARKET

The share of decentralized energy in the global mix will remain negligible in this scenario. Development will be limited to certain niche fields, like energy for remote areas or renewable energy generation at the most straightforward sites. Without steady growth and with the resulting weak capital inflows, as well as generally low interest, the likelihood of major technological breakthroughs and stronger price competitiveness will fall. The current status quo will hold and decentralized energy will have to wait for better times. → F

F

SCENARIOS FOR THE FUTURE OF DECENTRALIZED ENERGY SYSTEMS

2x2 matrix visualizes the projections

Market evolution: Strong – Weak
Political commitment: Low – High

FRAGMENTED EVOLUTION

- > Direct competition between central and decentralized energy systems
- > Decentralized energy systems will only penetrate attractive sectors
- > High entry barriers slow down transformation to a decentralized energy system

GREEN REVOLUTION

- > Favorable technological conditions meet regulatory support
- > Growing scale of decentralized energy system will lower costs
- > Fast transition to decentralized energy system without economic disruption

SLOW MOVING MAR-KET

- > Decentralized energy systems only in niche sectors
- > Low investments prevent technological breakthroughs
- > Status quo will hold

MARKET APATHY

- > Regulation drives high penetration of decentralized energy systems
- > Decentralized energy systems remain economically unattractive
- > High costs undermine public support

Source: Roland Berger

Policymakers and market players must act to make decentralized energy systems in Europe a success.

A shift toward decentralized energy systems in Europe seems inevitable. But current uncertainty means that success will depend on political reforms, regulatory change and market buy-in.

The scenarios we developed highlight the need for policymakers and market players to pursue similar goals if uncertainties are to be mitigated. But all four will have implications for both groups. The extent of these, and the necessary action to overcome them, are considered below.

POLICYMAKERS MUST COMMIT TO INTELLIGENT REGULATION

Policymakers will ultimately set the direction of travel toward a decentralized energy system. Only they have the power to mitigate growing global uncertainties, such as the US's recent pivot away from a greener energy policy, and make a concerted push toward decentralized/renewable energies. In Europe, this means regulators committing to set up decentralized systems.

The regulatory framework policymakers create for European businesses is crucial. Continuity in respect of political targets, for example on emissions, and government support schemes is key for companies to prosper. Individual European countries and regulatory bodies need to set up systems that allow markets to function across countries.

RENEWABLE ENERGY PROJECTS MUST BECOME MORE COMPETITIVE

To date, schemes to support the energy transition in Europe have largely been based on subsidies. These now need to be complemented by new policies that use market mechanisms to cut emissions, such as a renewed EU Emissions Trading System or a climate tax. While policymakers hold most of the cards when it comes to charting a course to decentralized energy, they also need to review how they play them. Legislation and incentives designed to improve energy efficiency and expand e-mobility, for example, have so far failed to spur demand. Yet such policy-setting interventions will be key to achieving European climate and energy targets.

Another area requiring action is the tender process for permitting/allotting new renewable energy projects. Its use is currently limited, placing constraints on competition. In the future, the tender process must be expanded to allow market mechanisms to drive down costs. In the wake of key policy decisions, the implementation of an integrated internal energy market in the EU is perhaps the single most important move toward a decentralized energy system. This would allow energy to flow freely across the bloc, balancing supply and demand, fostering investments in international infrastructure, improving competition between energy providers and ensuring the best energy prices. After all, due to standardized regulation, energy providers would have easy access to a market with about 450 million consumers.[6] In short, the role of policymakers cannot be overstated. If they do not act, the European energy market will remain fragmented and inefficient, Europe's energy dependence will increase and emissions targets will not be met.

MARKET PLAYERS MUST STRIVE FOR NEW BUSINESS MODELS

The shift to a decentralized energy system based on renewable sources entails significant new challenges for utility companies and manufacturers of energy infrastructure. But it also presents new opportunities, particularly regarding new business models. If market players want to stay competitive in a decentralized system and secure market share, they need to adapt and drive development.

Utilities have long relied on a time-honored business model: producing electricity in big power plants and delivering it to a mass consumer base. But with the advent of renewables and shift to decentralization this is now under threat. To adjust, they should reduce investment in central power generation and diversify toward decentralized sources. One option could be to separate central assets (nuclear, coal) from decentralized assets (renewables, storage facilities, transmission lines) and consider divesting/spinning them off.

There are also several options for new business models based on existing knowledge or infrastructure. Most obviously, the growing number of power generation units and disbursement of consumers in decentralized energy systems necessitate the building of transmission lines and micro grids (such highly localized power supply networks are becoming increasingly attractive to consumers). To develop these, utilities need to engage with local communities and commercial clients to tailor-make individual grids, offering new opportunities. Capital investment will be required to enable flexible power flows and intelligent grid solutions. Storage solutions, which are key to decentralized energy systems, present other options. Utilities should offer a portfolio of storage solutions to their customers. In addition, utilities should cooperate with large energy users of power-to-x facilities (power-to-gas, power-to-heat).

To push strong market evolution toward a decentralized energy system, utilities and manufacturers need to develop new business models that boldly embrace digitization and integrate decentralized energy sources.

Next up is digitization. Modern energy systems are data driven, and to maximize the potential of information collected from distributed sources, utilities need enhanced capabilities in data analytics.

New business models targeting commercial and private energy consumers are also emerging. For example, companies should take advantage of demand for consultant services for optimization of energy consumption, technology consulting or integration services.

Finally, added value models will be prerequisites. As markets become more transparent and flexible, con-

6 In 2015, the EU 27 (EU 28 without UK) had 444 million inhabitants. For 2030, Eurostat projects a population of 452 in the EU 27.

sumers are likely to switch to cheaper providers. This will mean utilities need to provide added value to retain customers, for example by offering smart household solutions and increased transparency in services. It should be noted, however, that to fully realize the potential of these new business models, utilities need to work with governments and regulators to create a market-friendly environment.

TECHNOLOGICAL INVESTMENT IS KEY FOR A DECENTRALIZED ENERGY SYSTEM

Manufacturers must also adapt to accommodate the shift to decentralized energy systems. The decline in fossil fuels and nuclear, for example, means equipment makers need to adjust product portfolios to accommodate decentralized solutions, and achieve scale to keep costs low. They must also invest in R&D and innovative companies to develop and secure access to leading technologies. This should include keeping an eye on interesting start-ups and cooperating with universities and research institutes.

More radical change to existing models may also be required. Manufacturers should not be afraid to harness digital tools, embrace new sales models such as pay-per-use or improve customer focus.

Failure by market players to adopt such measures could mean political forces make their business models obsolete and new players take their place.

LET'S SHAPE A BRIGHT FUTURE FOR A EUROPEAN DECENTRALIZED ENERGY SYSTEM

No one can be certain what the future holds for the world's energy system. There are simply too many political and market variables to exactly predict the energy mix and how it will be delivered.

But in Europe, one thing is for certain: The EU has decided to radically cut its carbon dioxide emissions. This will require a green revolution, and how the bloc achieves it will depend on whether it can decentralize its energy system.

To facilitate a future in which affordable energy is sourced and provided via a decentralized system, policymakers need to set the right course. But this will only succeed if it is supported by market players, who must develop and adopt new technologies and business models.

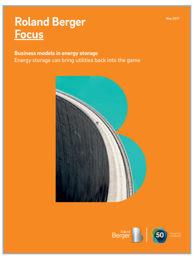
Our research shows that political commitment and market evolution are closely intertwined. High political commitment without market evolution, and vice versa, will not bring about successful decentralization. Therefore, policymakers need to set clear aims and pursue a step-by-step approach toward achieving that goal. This will allow market players to adapt as the regulatory environment changes, thereby driving market evolution and securing their competitiveness in a future decentralized energy system, which, ultimately, gives power to the people. ◆

ABOUT US

Roland Berger, founded in 1967, is the only leading global consultancy of German heritage and European origin. With 2,400 employees working from 34 countries, we have successful operations in all major international markets. Our 50 offices are located in the key global business hubs. The consultancy is an independent partnership owned exclusively by 220 Partners.

Navigating Complexity
Roland Berger has been helping its clients to manage change for half a century. Looking forward to the next 50 years, we are committed to supporting our clients as they face the next frontier. To us, this means navigating the complexities that define our times. We help our clients devise and implement responsive strategies essential to lasting success.

FURTHER READING



BUSINESS MODELS IN ENERGY STORAGE
Energy storage can bring utilities back into the game

With energy storage becoming an important element in the energy system, each player in this field needs to prepare now and experiment and develop new business models in storage. In our report, we highlight the various needs for energy storage and examine the first cases in deploying energy storage. We sketch outlines of future business models and draw recommendations for the players in the energy value chain.

ROLAND BERGER TREND COMPENDIUM 2030
Megatrend 4: Climate change & ecosystem at risk

The Roland Berger Trend Compendium 2030 is a global trend study describing the seven most important megatrends that will shape the world between now and 2030. Megatrend 4, Climate change & ecosystem at risk, takes a detailed look at what growing energy demands mean for the future of our climate and ecosystem if we don't convert our energy supply to more renewables and a decentralized energy system.

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