

Module Outline

# **CORPORATE ENERGY POLICY AND STRATEGY**





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## Relevance and Background

Reducing carbon emissions from the power sector and energy use is essential to meeting the Paris climate targets and the UN Sustainable Development Goals (SDGs). International organizations such as the International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and Intergovernmental Panel on Climate Change (IPCC) have outlined clean energy transition scenarios that necessitate a dramatic rise in renewable energy, particularly solar energy, in developing countries and emerging economies in the coming decades.

Corporates can play a significant role in addressing climate change due to their economic influence, innovation capacity, and ability to drive change at scale. However, in order to do so, they must have documented targets, formulated strategies to meet the targets, allocate resources and clearly roles and responsibilities. All of these coalesce into an Energy Policy.

Theme – Policymaking

Competency – Policymaking

Code of the Module – T05C11M30

## Learning Outcomes

The participants shall be conversant with:

- The meaning of Corporate Energy Policy and why corporates need to have one
- Different strategies that countries can adopt for development of solar energy and roadmaps that they can develop for the same.


An overview of the above topics would equip them with the necessary exposure so that they can contribute in developing their countries' solar strategies and roadmaps and guide corporates in designing appropriate energy policies.

## Method of Delivery

Duration	Resource Code	Resource Delivery
60 min.	M30 L01	Lecture on Corporate Energy Policy and Strategy

## M30 L01: Lecture Presentation

The MS PowerPoint presentation has two sections. The first section covers Corporate Energy Policy in which the concept of energy policy is explained. An energy policy of an organisation needs to overcome the barriers that an organisation faces in adopting improved energy management practices. These barriers are explained in the presentation. Thereafter, the presentation explains the steps that an organisation needs to take in developing an energy policy.



The second section of the presentation covers Energy Strategy and Roadmap. This is at the macro or country level and explains how a country can design its solar energy strategy and what are the steps that need to be undertaken to develop a roadmap to meet the strategy.

## Key Topics to be Covered

- 1 What is Corporate Energy Policy?
- 2 Why is an energy policy needed?
- 3 Barriers to adoption of renewable energy
- 4 How can a corporate design its Energy Policy?
- 5 How can a country develop its solar energy strategy?
- 6 Developing a roadmap for solar energy development
- 7 The Global Scenario - A Roadmap for 2050 based on 100% RE



## Table of Contents

1	What is Corporate Energy Policy? .....	6
2	Why is an Energy Policy Needed? .....	7
3	Barriers to Adoption of Renewable Energy .....	8
4	How can a Corporate Design its Energy Policy? .....	11
5	How Can a Country Develop its Solar Energy Strategy? .....	17
6	Developing a Roadmap for Solar Energy Development .....	19
6.1	Phase 1: Planning and Preparation .....	19
6.2	Phase 2: Visioning .....	19
6.3	Phase 3: Roadmap Development .....	20
6.4	Phase 4: Roadmap Implementation, Monitoring and Revision .....	20
7	The Global Scenario - A Roadmap for 2050 based on 100% RE .....	21



## 1 What is Corporate Energy Policy?

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In the pursuit of systematically enhancing energy and carbon efficiency, companies must seamlessly integrate energy management into their overarching strategy, organizational structure, and daily operations (Böttcher and Müller 2016). Fulfilling this crucial need is the function of an energy policy document. In fact, the corporate energy policy should be an integral component of the organization's sustainability policy or plan, designed to advance environmental performance, which, in turn, mirrors the company's mission statement and core values. It plays a pivotal role in delineating senior management's long-term directives concerning energy matters, underscores senior management's unwavering support for energy management, and encapsulates objectives, such as the reduction of energy consumption and the implementation of energy management systems (Thollander and Ottosson 2008).

## 2 Why is an Energy Policy Needed?

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Developing a corporate energy policy is crucial for several reasons:

- **Cost Reduction:** Implementing an energy policy enables an organization to identify and implement energy-saving measures, leading to cost reduction. By adopting energy-efficient technologies, optimizing energy consumption, and managing energy usage effectively, a company can lower its energy expenses and improve its bottom line.
- **Sustainability and Environmental Responsibility:** Developing an energy policy demonstrates a company's commitment to sustainability and environmental responsibility. By setting targets and guidelines for reducing energy consumption and carbon emissions, an organization can contribute to mitigating climate change and reducing its ecological footprint.
- **Compliance and Regulatory Requirements:** Many jurisdictions have enacted energy-related regulations, such as energy efficiency standards and reporting requirements. A well-defined energy policy ensures compliance with these regulations, helping a company avoid penalties and legal issues.
- **Reputation and Stakeholder Expectations:** Consumers, investors, and other stakeholders increasingly value companies that demonstrate environmental consciousness and sustainability efforts. By establishing an energy policy, an organization can enhance its reputation and meet the expectations of socially responsible stakeholders.
- **Risk Management:** Energy availability, price volatility, and supply chain disruptions can pose risks to businesses. An energy policy allows companies to assess and manage these risks proactively. By diversifying energy sources, adopting renewable energy, and implementing energy-saving measures, an organization can improve its resilience and reduce its exposure to energy-related risks.
- **Employee Engagement and Productivity:** An energy policy creates a framework for involving employees in energy management initiatives. By promoting energy-conscious behavior, providing training on energy efficiency, and encouraging employee suggestions, an organization can foster a culture of sustainability, leading to increased employee engagement and productivity.
- **Innovation and Competitive Advantage:** Developing an energy policy encourages companies to explore innovative energy solutions and technologies. By staying ahead of energy trends and investing in clean and renewable energy sources, a business can gain a competitive edge in the market, attract customers who prioritize sustainability, and position itself as a leader in the industry.

Overall, a corporate energy policy aligns an organization's energy goals with its overall business objectives, helping it optimize energy usage, reduce costs, mitigate risks, enhance its reputation, and contribute to a more sustainable future.

### 3 Barriers to Adoption of Renewable Energy

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An energy policy documents the justification (Why do it) for pursuing performance improvements and ensures the organization's top-level commitment to achieve carbon emissions' reduction targets. The policy should also identify the barriers and build on the drivers for change. The major barriers to adopting energy efficiency measures and large-scale adoption of renewable energy are:

- **Low Capital Availability** is a recurring and relevant economic obstacle for energy efficiency investments and procurement of RE. In large organizations, however, this low availability is mainly due to the low priority of energy in the overall business decisions of the organization. This low priority reveals the organization's strategic view on energy efficiency and renewable energy. While access to external funding and lack of own capital are reported as causes for this barrier in small and medium enterprises, opportunity costs and allocation of capital to other non-energy projects which are part of the core business of the organization might be the reason in large enterprises.
- **The Risk of Production Disruptions** is regarded as a critical barrier in both non-energy intensive and energy intensive organizations. Production disruptions lead to less production, less revenues and hence lower profits.
- **Lack of Awareness**, lack of **Governmental Initiatives** (e.g., policies or financial incentives) and time to implement energy management interventions creates gaps in knowledge that hinder adoption of energy-efficient technologies and renewable energy.

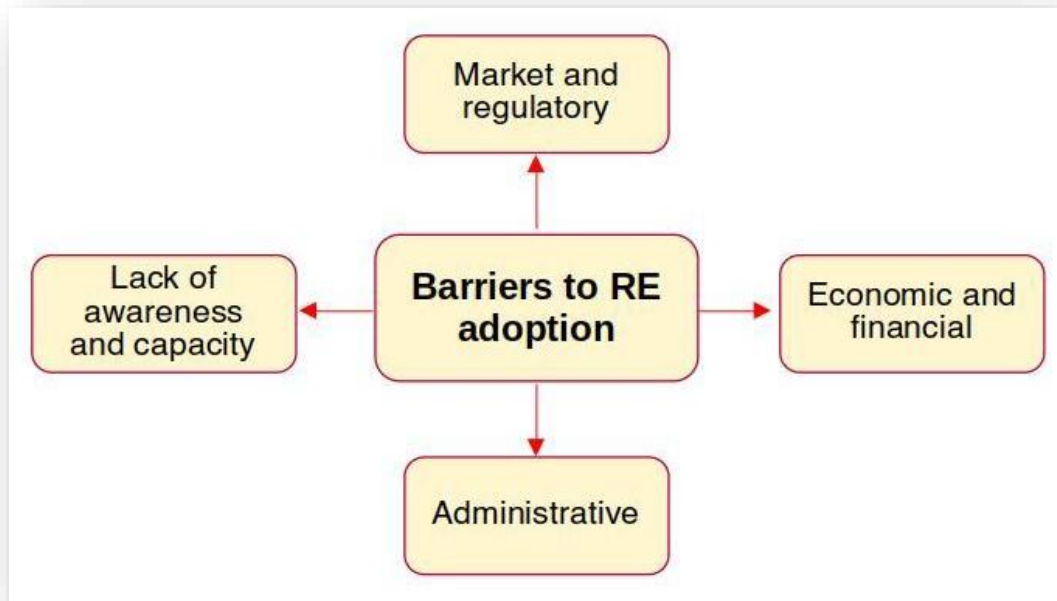
The characteristics of the companies, particularly their size (number of personnel) and energy intensity, influence how barriers are seen. For instance, small businesses are more sensitive to hurdles than medium and big businesses are since the latter have a tendency to dedicate human and financial resources to energy management and energy efficiency concerns more readily. In general, non-energy intensive sectors face larger barriers than their energy intensive counterparts. This is due to the fact that energy-intensive production processes have a greater ratio of energy costs to total production costs, which may cause energy issues to be given more priority in energy-intensive companies than in non-energy-intensive businesses. For organisations that have overcome the identified barriers and operate with maximum energy efficiency, achieving further carbon emissions reductions, or even carbon neutrality, becomes the next strategic goal.

Overall barriers to large-scale adoption of RE by corporates can be broadly categorized into the following:



- **Market, Technical and Regulatory Barriers:** the lack of an adequately competitive regulatory environment for private enterprises is caused by market, technical, and regulatory restrictions. The regulated energy markets are dominated by monopolists and de facto monopolists. In some countries, the inability of new entrants to reach the market is accompanied by onerous administrative and institutional complications. The security of the energy supply is impacted by inadequately structured trading frameworks on regional marketplaces while certain nations lack sufficient generating capacity. Due to the regional market's extreme fragmentation, large-scale, cost-effective projects that could benefit the entire region are less appealing to investors. Investors have also been turned off by the introduction of retroactive regulations on the delivery of renewable energy in several nations. Setting cost-reflective energy price signals, which are required to entice new investments in renewable energy, would help establish a competitive integrated energy markets among countries in a particular region - Southeast Europe's nations and their EU neighbors, South Asia, etc., are such examples.
- **Economic Barriers:** The real cost of providing energy is not covered by state-regulated electricity tariffs, yet established utilities have access to a variety of governmental subsidies to make up the income difference whereas new independent investors do not. Public funding is frequently insufficient to support such initiatives at scale, and banks frequently lack experience with renewable energy projects. The need of the hour is to design various sorts of financial support, such as grants, subsidies, feed-in tariffs, and tax incentives, in order to promote the growth of renewable energy projects.





- **Administrative and Legal Barriers:** These typically encompass excessively cumbersome bureaucratic obstacles, unnecessary complexity in permitting procedures, legal ambiguities arising from shifting legislation, a lack of cooperation, poorly defined lines of authority among various authorities, protracted and intricate processes for obtaining zoning and siting permits, and unresolved property issues, among other administrative concerns.
- **Lack of Awareness and Capacity:** The most pressing issue centers on the lack of awareness, capability, and professional competencies, as qualified and well-organized individuals are essential to initiate any transformation. This deficit pertains to policymakers, renewable energy project financiers, technology and engineering providers, and consumers.

## 4 How can a Corporate Design its Energy Policy?

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Large corporations annually allocate millions, if not billions, of dollars directly to energy expenses, along with millions more encompassing indirect costs related to supply chains, outsourcing, and logistics. Yet, the predominant viewpoint among many businesses, particularly those outside energy-intensive sectors, is to perceive energy merely as an expense to be managed. This perspective, however, represents a strategic error, overlooking significant opportunities to mitigate risks, enhance resilience, and generate new value.

In the contemporary landscape shaped by far-reaching environmental, social, and business trends, including climate change and global carbon regulation, increasing demands on natural resources, escalating standards for corporate environmental performance, innovations in energy technologies and business models, and declining prices of renewable energy, energy has risen to prominence on the corporate agenda. These macro-trends have redefined the business environment, exposing companies to novel perils, while concurrently presenting fresh avenues for value creation.

In accordance with Michael Porter's traditional strategy theory, companies can gain a competitive edge by either minimizing costs or differentiating themselves. Decisions related to energy procurement and utilization can profoundly impact a company's cost structure. Furthermore, the management of energy's impact on the environment and climate, especially concerning carbon emissions, is now an increasingly vital differentiating factor for consumers, investors, and corporate clients.


Leading companies spanning various industries have initiated energy strategies; however, they often lack a comprehensive playbook. While there are indeed effective frameworks for managing energy, they are not specifically tailored to address the strategic implications of these global mega-trends, nor are they adequately linked with overarching strategic objectives. The following steps offer a structured approach to constructing a robust energy strategy and systematically applying it to an organization's energy utilization (Winston 2017).

- **Start at the Top:** Without the active involvement of the CEO and the establishment of a well-defined governance structure, putting an energy strategy into action is a challenging endeavor. Typically, the CEO's mandate begins with a commitment, initially within the company, to make energy strategy an integral part of the firm's purpose and competitiveness. The CEO should underscore the significance of this commitment by designating a senior executive to serve as a champion and guide. In organizations where operations and energy consumption are paramount, such as industrial and petrochemical manufacturers, the COO may be the most suitable choice for this role. In firms where energy sourcing and financing take precedence (for example, in the ICT and retail industries), the CFO may be an ideal fit. This appointed executive assembles a cross-functional team responsible for crafting the company's energy strategy and overseeing its implementation. This team should encompass executives from operations, facilities, finance, legal, procurement, sustainability, and potentially other departments. For instance, Microsoft's energy team includes members from the environment and sustainability, legal, finance, and data center operations, reporting to the VP for cloud



infrastructure and operations, as well as the VP for technology and civic engagement. EMC, a data service firm (now part of Dell), manages its energy team under the purview of the CFO.

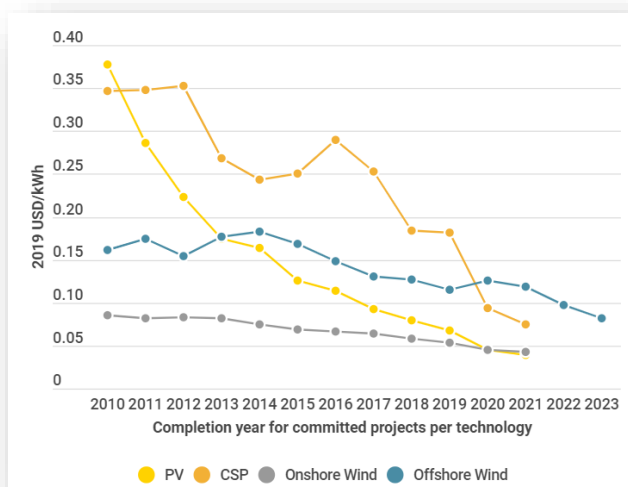
- **Integrate Energy into the Company's Vision and Operations:** The team's initial task is to evaluate the company's internal and external energy effects. Questions that should be addressed include: How much energy does our company consume and what is the cost associated with it? What effect does this expenditure have on key financial metrics like cost of goods sold? Are we taking advantage of the chances to utilize renewable energy sources? What is the carbon footprint of ourselves and our suppliers? How does this match up with customer, investor, and employee expectations, and how do we measure up against our competitors?
  - Answering these questions will quickly uncover areas of potential improvement and areas of deficiency. For instance, a large-scale retailer can calculate the cost savings potential from addressing the gap by measuring its energy use per square foot of retail space. The company can also evaluate its yearly rate of energy reduction. Retailers with well-developed energy programs have been able to achieve sustained annual decreases of between 2.5% and 3.5%. These savings represent a considerable amount of money on hundreds of millions of dollars of energy expenditure. Calculations of carbon intensity would illustrate the company's vulnerability to fuel price fluctuations and demonstrate its success in transitioning to renewable energy sources.
  - After the team has a thorough understanding of the company's energy impacts, they can create an action plan with multiple main areas of attention, starting with a suggestion to the CEO for precise energy and emissions objectives. Ambitious goals should reflect the magnitude and speed of emissions reductions that scientists have determined are necessary to address climate change. Nearly 200 of the world's biggest companies have consented to establish science-based targets, and over 80 firms have joined the global initiative RE100, which obligates an organization to transition to 100% renewable energy. An increasing number of companies are also mandating that their supply chains adhere to science-based targets. Establishing public goals not only demonstrates the company's dedication to external stakeholders, but also helps to coordinate the various departments within the organization, holds people accountable, and motivates employees.
  - After the targets have been established, the team must devise incentives to motivate people across the organization to prioritize energy efficiency. As an example, General Motors, which spends more than \$1.2 billion on energy each year, has incorporated energy efficiency into its global and plant business plans. The plans, which are closely related to the remuneration of plant managers, include not only the anticipated operational metrics such as production volumes but also energy and environmental key performance indicators such as the energy consumed per vehicle manufactured. If managers do not meet their energy goals, they must provide an explanation to global leadership. According to Mari Kay Scott, GM's director of environmental compliance and sustainability, energy efficiency is "imperative" in the plant, alongside safety, quality, cost, and responsiveness. Ultimately, the energy team can bridge the gap between two usually separate processes: obtaining energy and managing its consumption. Generally, managers in one area of the organization are mainly



concerned with purchasing energy at the most economical cost and creating a budget and risk strategy; while managers in other areas are striving to reduce consumption and enhance efficiency. Synchronizing those activities can result in cost savings, revenue generation, and risk reduction. For instance, procurement managers may opt for energy contracts with higher costs during peak demand times on the grid in exchange for lower rates during off-peak periods. The demand-side managers could adjust consumption to avoid peak times and even receive demand-response payments from utilities for reducing usage during peak periods. Companies are also exploring ways to reduce their peak-use demand by utilizing energy storage. As an example, Kendall-Jackson wineries has employed batteries from a Tesla/EnerNOC pilot program to store energy from its solar panels. This resulted in a 40% decrease in the winery's energy bill in 2016, saving it \$2 million, and also made it more resilient to potential power outages.

- **Track Energy at All Levels:** Energy is one of the most expensive areas for businesses, alongside personnel, product costs, facilities, and equipment, yet it is the only one that is not closely monitored and managed. In fact, it is usually the most significant part of a company's cost structure that is not adequately monitored. Many companies lack efficient systems for quickly obtaining energy data or data that can be used to make decisions. Keeping track of and examining energy consumption can uncover operational problems that have an impact on costs, performance, and quality. For instance, "energy signature" data may indicate that a piece of equipment, such as an HVAC system or an injection-molding machine, is operating outside its ideal parameters. Blommer Chocolate, a major cocoa-bean processor, employs statistical analysis to forecast the energy needed for each pound of product roasted. If the actual consumption differs from the forecast, managers are aware that something is amiss.
  - Companies should also analyze the energy usage of their customers further down the value chain. For certain industries, the energy and carbon footprint of their products during use is a major factor in distinguishing them from their competitors. Many of the major tech and automotive firms have established ambitious energy-efficiency objectives for their products. These advances reduce costs and make products stand out, which in turn increases sales and customer loyalty.
- **Shift to Renewable Energy Sources:** The clean energy technology market is rapidly evolving, and businesses must be aware of both the technologies and their financing options. Companies that are not actively incorporating renewables and other new energy technologies into their energy plans are missing out on potential advantages and exposing themselves to a variety of risks. The current energy landscape is characterized by a dramatic surge in the supply and a sharp decrease in the cost of a variety of alternative energy technologies, including wind turbines, photovoltaics, biofuels, fuel cells, advanced batteries, LED lighting, and advanced meters. The most recent renewable-energy initiatives are pricing energy lower than any other source of power. By 2015, the average cost of electricity from new long-term-contract wind power projects in the United States had decreased by five cents to two cents per kilowatt-hour since 2009. In sunny regions such as the Middle East and Mexico, the cost of new solar projects is now lower than three cents per kilowatt-hour.

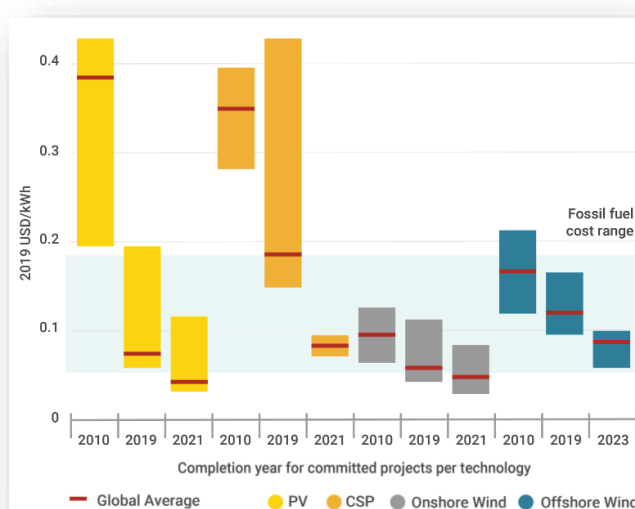
As is the case with all energy sources, government incentives make the economics of this more appealing. Even without assistance, the cost of clean technology is plummeting rapidly. In the span of only five years, the total expenses of creating solar and wind energy have decreased by 74% and 55%, respectively. The cost of LED light bulbs has decreased dramatically by 94% in less than ten years. The cost of storage technologies, such as batteries which address the issue of intermittency in renewable energy sources, is also declining rapidly.



The cost of renewable energy has been reducing due to large-scale investments and rapid technological progress, leading to a predictable shift in the market. Since 2012, more than half of the new energy added to the global grid annually has come from renewable sources.

### Financing of RE

Although clean energy technologies are becoming more widespread and their costs are decreasing, it is not always simple for businesses to benefit from them. To do this effectively, one must have a thorough understanding of the financial and risk implications of the various purchasing options. The most employed renewable energy financing instrument is the power purchasing agreement (PPA) ("5 Charts Show the Rapid Fall in Costs of Renewable Energy" 2020). The most basic form of this is a 10-to-20-year agreement to purchase renewable energy at a fixed cost, typically from a wind or solar farm. Financial and operational executives may be hesitant to sign long-term contracts, despite the attractive prices. As with all hedges, PPAs involve a risk: Energy prices are highly unpredictable, and even renewable energy contracts signed at a lower price than current costs do not guarantee success. Savvy companies recognize the worth of PPAs as a way to protect against price fluctuations and gain a competitive edge.






any upcoming regulations. Already, 40% of the world's emissions are subject to some kind of carbon pricing, and with the Paris climate accords coming into effect in late 2016, there is a strong likelihood of further global carbon regulation, regardless of the United States' involvement. Governments globally are also implementing ambitious energy-efficiency regulations. Another benefit of clean technologies is the ability to reduce business continuity risk. Finally, clean energy commitments provide brand benefits and opportunities for competitive differentiation. Social pressure to reduce emissions is rising, and clean brands and offerings can effectively engage all kinds of stakeholders.

- **Engaging key Stakeholders:** Companies may be adept at the practical aspects of energy strategy: improving efficiency, diversifying energy sources, lowering emissions, and so forth. However, without a well-thought-out plan for engaging with stakeholders, these efforts are limited in their effectiveness. Companies must collaborate with governments to shape energy and environmental regulations that impact their businesses, and they should communicate their energy strategies to customers, communities, investors, and employees, customizing the messages to the specific interests of each.

The clean energy market is developing quickly. Companies no longer have to purchase power from a local, regulated utility and can now negotiate with energy providers, even competing against each other to win the business. They can manage costs more effectively through dynamic pricing, new financing mechanisms such as PPAs, and incentives such as tax credits for improving efficiency and investing in renewable energy sources. They can also employ smart grid, battery storage, and on-site power-generation technologies to determine the optimal amount of electricity to purchase from the grid. However, the capacity to take advantage of these advances is increased and hastened by conducive government policies, including regulations that support renewable energy. Consequently, companies have a vested interest, whether they are aware of it or not, in aiding the development of a progressive and forward-thinking regulatory system.





The most significant obstacle is the belief that energy is either an expense to be managed or that strategically managing it is too costly. It is clear that energy initiatives, like any other business endeavour, require some form of investment-whether it be in terms of money, time, or organizational attention. Nevertheless, these investments bring considerable advantages to the business and do so quickly.



## 5 How Can a Country Develop its Solar Energy Strategy?

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The solar energy strategy of a country refers to a comprehensive plan that outlines the goals, policies, and actions to be taken by the government and relevant stakeholders to promote and maximize the use of solar energy within the country. A solar energy strategy addresses the specific objectives and targets the country aims to achieve in terms of solar energy generation and deployment. It serves as a guiding framework to harness the potential of solar power as a renewable and sustainable energy source, while contributing to the country's broader energy and environmental goals. By formulating and implementing a solar energy strategy, a country aims to leverage its solar resources, reduce dependence on fossil fuels, mitigate climate change impacts, create new job opportunities, enhance energy security, and contribute to sustainable development in the long run.

Developing a solar energy strategy involves careful planning and consideration of various factors. Here are some steps a country can take to develop its solar energy strategy:

- **Set Goals and Targets:** The country should establish clear goals and targets for solar energy development. These goals could include targets for installed solar capacity, renewable energy generation, reduction in carbon emissions, or energy independence.
- **Assess Solar Resource Potential:** Conduct a comprehensive assessment of the country's solar resource potential. This involves evaluating the availability of sunlight throughout the country, identifying suitable locations for solar installations, and estimating the potential electricity generation capacity.
- **Create Supportive Policies and Regulations:** Develop and implement supportive policies and regulations to encourage solar energy development. This may include incentives such as feed-in tariffs, tax credits, grants, or subsidies for solar installations. Clear and streamlined permitting processes can also facilitate the development of solar projects.
- **Build Institutional Capacity:** Strengthen the institutional capacity to support solar energy development. This may involve establishing dedicated government agencies or departments responsible for renewable energy planning and implementation. These institutions can provide technical expertise, promote research and development, and facilitate collaboration with stakeholders.
- **Foster Private Sector Participation:** Encourage private sector participation in solar energy development. This can be achieved by creating a favorable investment environment, providing financial incentives for private investors, and promoting public-private partnerships. Engage with local and international companies to attract investments and leverage their expertise in solar technologies.
- **Develop Infrastructure:** Develop the necessary infrastructure to support solar energy deployment. This includes building transmission and distribution networks capable of accommodating the increased penetration of solar power. Additionally, establish charging infrastructure for electric vehicles to encourage their adoption alongside solar energy.
- **Promote Research and Development:** Invest in research and development to drive innovation in solar energy technologies. Support research institutions, universities, and

private companies to develop new and more efficient solar technologies, energy storage solutions, and grid integration systems.

- **Encourage Community Engagement and Education:** Promote public awareness and education about the benefits of solar energy. Engage with local communities to address concerns and ensure their active participation in solar projects. Encourage the adoption of solar energy at the residential and community levels, fostering a culture of sustainable energy practices.
- **Monitor and Evaluate Progress:** Establish mechanisms to monitor and evaluate the progress of the solar energy strategy. Regularly assess the achievement of targets, identify challenges, and make necessary adjustments to policies and strategies based on the outcomes.
- **International Collaboration:** Engage in international collaborations and partnerships to learn from other countries' experiences and leverage global expertise in solar energy development. Collaborate on research, technology transfer, and capacity-building initiatives to accelerate progress.



Each country's approach to developing a solar energy strategy may vary depending on its unique circumstances, available resources, and policy framework. Customizing the strategy to fit the specific needs and conditions of the country is crucial for successful implementation.

## 6 Developing a Roadmap for Solar Energy Development

In October 2019, International Energy Agency (IEA) and International Solar Alliance (ISA) collaborated to bring out a report titled 'Solar Energy: Mapping the Road Ahead', the objective of which is to provide government, industry and civil society stakeholders with the methodology and tools to plan and implement national and regional solar energy roadmaps. The guide details out an approach to roadmap development which involves two streams of activities (analysis and consensus-building) in four phases (planning and preparation; visioning; roadmap development and implementation; and monitoring and revision). It underlines the importance of the process of devising a roadmap as the roadmap itself for ensuring the success of solar energy technologies ("Solar Energy Mapping the Road Ahead" 2019).

*Figure SEQ Figure \\* ARABIC 1: The roadmap development process*

*Note: Dotted lines indicate optional steps, depending on available capabilities and resources.*

*Source: Adapted from IEA (2014a), Energy Technology Roadmaps*

### 6.1 Phase 1: Planning and Preparation

The planning and preparation stage entails assessing the technological, market and public policy environment pertinent to the solar technologies outlined in the roadmap. To gain a full understanding of solar potential and resources, a thorough analysis must be conducted.



Given the broad scope of essential solar energy stakeholders in many countries, it is essential to recognize them early on and contemplate how they should be included in the road mapping process at the various levels of engagement (Responsible, Authorized, Consulted and Informed).

### 6.2 Phase 2: Visioning

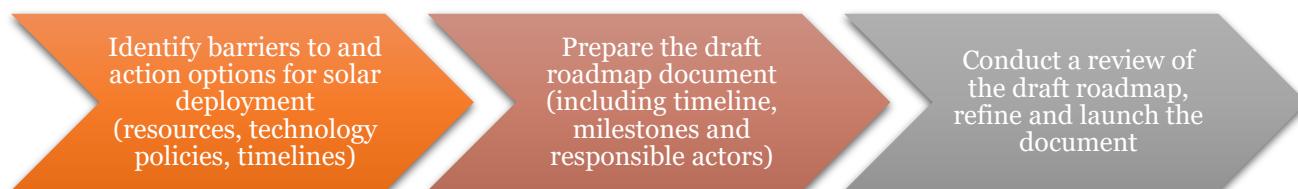
The second step of the road mapping process involves creating a vision for the deployment of solar technology in the country or region over a predetermined period of time. It is essential to articulate the motivations for using solar energy clearly in order to create the vision and long-term objectives of the roadmap.



Establishing clear and achievable goals is a key element of any national or regional roadmap's guiding vision. A clear vision and realistic objectives make it easier to execute a roadmap successfully, especially when the goals are mandatory rather than merely desired. Even though the energy infrastructure, energy demand patterns, and solar resource availability vary from one nation to the next, global analyses can still be useful in providing direction.

### 6.3 Phase 3: Roadmap Development

The following stage, roadmap development, focuses on recognizing the obstacles to solar technology implementation, as well as the steps required to surmount them and the individuals responsible for executing them. Barriers can be non-financial, including institutional, administrative, licensing, and public acceptance issues, among others. Alternatively, they can be economic in nature, usually stemming from flaws in the framework or market design that amplify the perceived risks for investors and lenders.



### 6.4 Phase 4: Roadmap Implementation, Monitoring and Revision

The fourth and last stage of roadmap development involves monitoring its implementation and setting up a system for regular revisions. This is an ongoing process, with tracking and monitoring taking place regularly through a range of indicators. Support mechanisms and objectives should also be regularly updated and adjusted since even established solar technologies are still rapidly developing and costs are still decreasing. If support mechanisms are in the form of a subsidy, it should not be overly generous to the detriment of taxpayers; at the same time, goals should be increased as costs decrease, which would justify a larger solar contribution to the nation's energy requirements and economic growth.



## 7 The Global Scenario - A Roadmap for 2050 based on 100% RE

A study was undertaken by Stanford University in 2017 to develop roadmaps for 139 countries for which raw energy data are available. The roadmaps describe a future where all energy sectors are electrified or use heat directly with existing technology, energy demand is lower due to several factors, and the electricity is generated with 100% wind, water, and sunlight (WWS or RE). The roadmaps are not a prediction of what might happen. They are one proposal for an end-state mix of RE generators by country and a timeline to get there that is believed to largely solve the world's climate-change, air-pollution, and energy-security problems. However, the mixes proposed are not unique, because many combinations of RE generators can result in stable, low-cost systems of energy production, distribution, storage, and use (Jacobson et al. 2017).

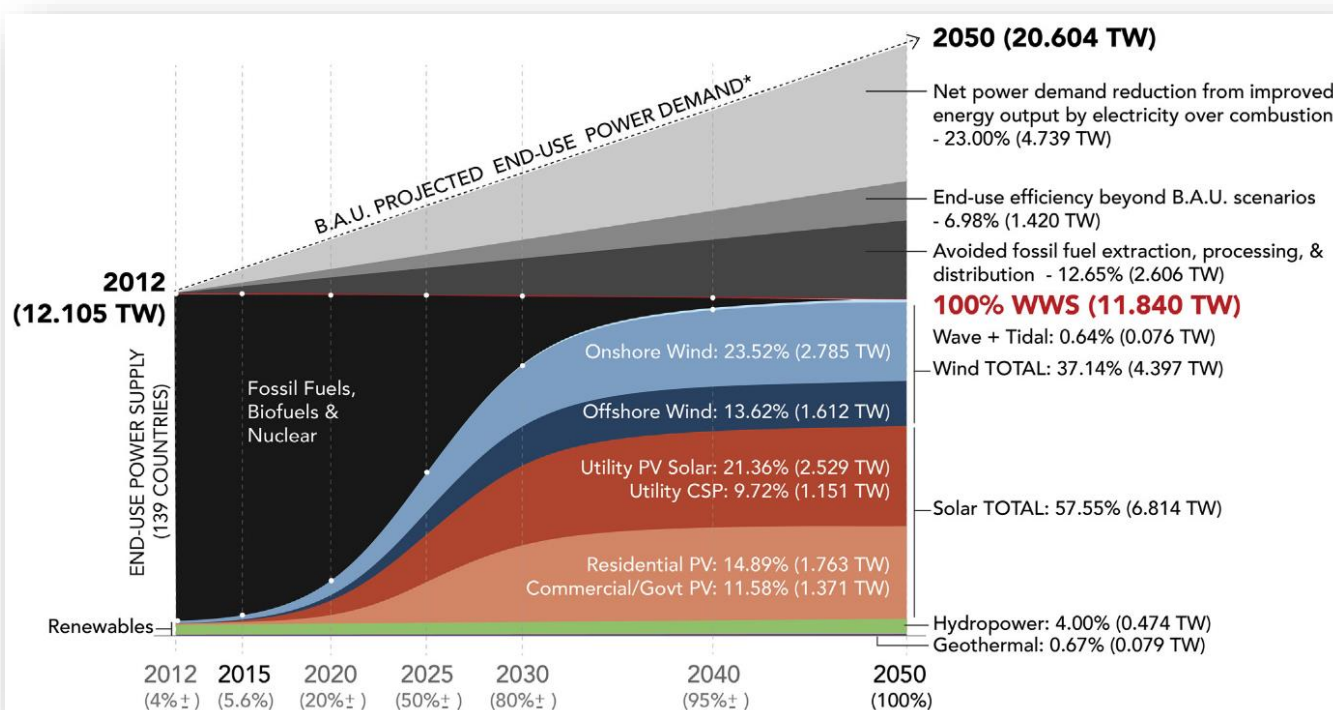



Figure 1: Projected global share of RE in 2050 (Source: IRENA, 2022)

Deploying PV according to the vision of this roadmap requires strong, consistent, and balanced policy support. The five main areas of policy interventions include:

- Creating a policy framework for market deployment, including tailored incentive
- schemes to accelerate market competitiveness.
- Improving products and components, financing models and training and education to foster market facilitation and transformation.
- Supporting continuing technology development and sustained R&D efforts to advance the cost and efficiency improvements.

- 
- Improving international collaboration to allow for accelerated learning and knowledge transfer to emerging and developing countries.

Meeting the ambitious deployment objectives set and overcoming existing obstacles will necessitate targeted action across the entire PV value chain (e.g. raw materials, module technologies, balance of system components), and throughout the product development lifecycle from basic research to demonstration and deployment. In addition, measures must be taken to promote the development of technologies that will enable the widespread implementation of PV, such as energy storage and grid integration technologies. This section outlines a series of key steps to develop a policy framework that will directly or indirectly facilitate the successful deployment of large-scale PV systems. The next ten years are a crucial period for policy action to realize the PV vision outlined in this roadmap, and more specific steps can be identified during this time.



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