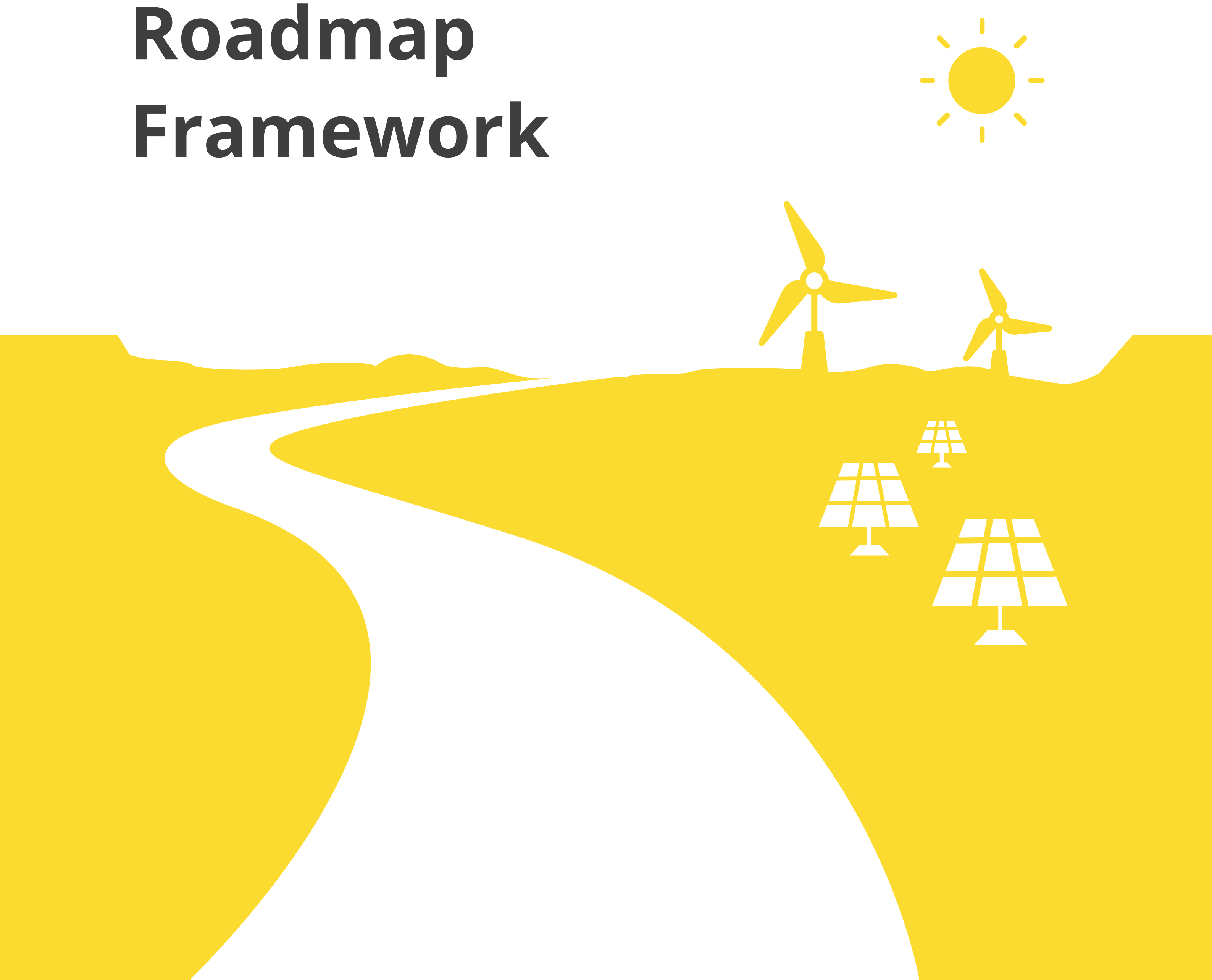
100% Renewables Cities and Regions Roadmap Framework



ICLEI Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

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ABOUT ICLEI

ICLEI – Local Governments for Sustainability is a global network of more than 2500 local and regional governments committed to sustainable urban development. Active in 125+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. Our members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

ACKNOWLEDGEMENTS

The 100% Renewables Cities and Regions Roadmap project facilitates the energy transition by raising local awareness on renewable energy sources, showcasing how local and national governments can create coordinated enabling frameworks and policies, exploring access to public and private sector finance, and building local renewable energy projects to address electricity, heating and cooling.

The 100% Renewables Cities and Regions Roadmap project is implemented by ICLEI – Local Governments for Sustainability and funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI).

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OBJECTIVE

The 100% Renewables Cities and Regions Roadmap Framework is a knowledge product that supports local governments, experts, and individuals, to aid in the development of a 100% renewable energy roadmap, either for a single sector such as electricity, heating, or transportation, or across multiple sectors.

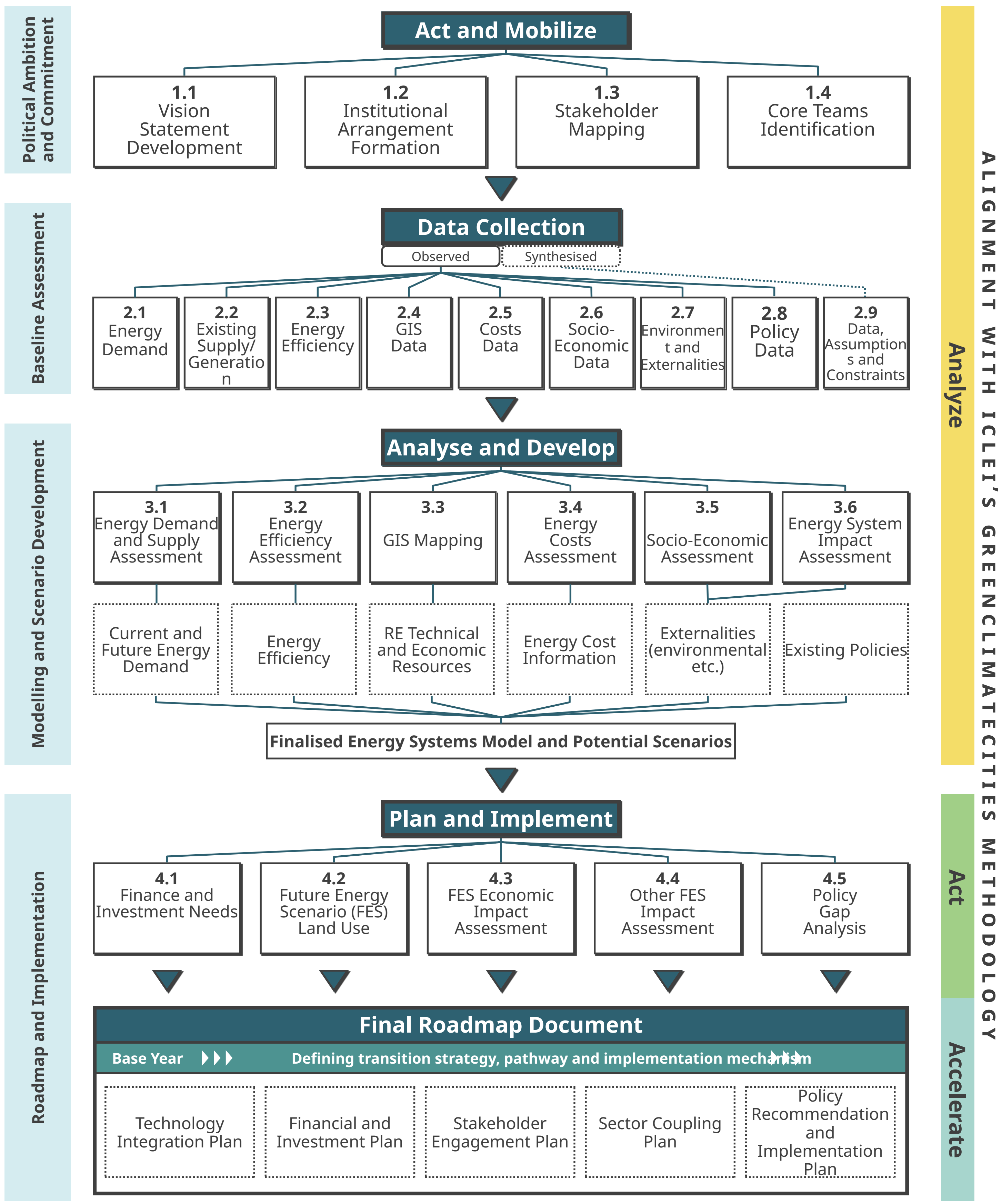
This document presents the interrelated and interconnected processes whose individual consideration forms a robust final roadmap. This document therefore informs interested individuals about a structured and integrated approach to developing a roadmap that charts the way towards achieving the objective of 100% renewable energy.

HOW TO USE THIS FRAMEWORK

This Framework guides local governments, organizations, planners, and experts towards developing a pathway for transitioning towards 100% renewable energy. Therefore, there might be the need for adjustments to the individual processes or components of the framework based on local context, specific circumstances, and other related criteria.

The Framework is also not intended to serve as a to-do list but rather as a showcase of good practices and a constellation of steps and phases that could be adopted in part or as a whole, based on individual circumstances and contexts.

100% RENEWABLES CITIES AND REGIONS ROADMAP FRAMEWORK



1. POLITICAL AMBITION AND COMMITMENT

1.0 Act and mobilize

Back to framework

The roadmap development process starts with the creation of a narrative that describes in quantitative terms future goals and expectations (Williams and Waisman 2017).

The 'Political Ambition and Commitment' phase is the **preparatory phase** consisting of joint vision creation (Wehner et al. 2017). It establishes the **commitment of the local government** to its strategic direction, and cements the importance of the transition to 100% renewable energy (ICLEI: Marques et al. 2016).

The overarching goal is to **act and mobilize capacity** to achieve a firm commitment towards 100% renewable energy. This can be done through the creation of a **vision statement**, **identifying concerned institutional arrangements and key stakeholders**, the formation of **core teams**, and a **definition of the 100% RE scope**.

Political commitment by the local government, buy-in from key actors or stakeholders, and the identification of challenges, barriers, and opportunities are key outputs of this phase, which can then further inform policy and strategic direction (ICLEI: Marques et al. 2016).

It is analogous to the "Analyze" phase of the GreenClimateCities methodology and framework put forward by ICLEI (ICLEI: Marques et al. 2016) in partnership with the United Nations Human Settlements Programme (UN-Habitat).

1. POLITICAL AMBITION AND COMMITMENT

1.1 Vision statement development

Back to framework

A vision statement highlights the current state of the local government's renewable energy status and its **mid- to long-term energy targets**.

The first step in writing a vision statement is determining who will play a role in crafting it, and ways to capture a range of stakeholder voices. It is also important for the vision statement to be broken down to answer questions such as:

- ***What*** is the current energy, environmental and economic situation?
- ***Why*** should an energy transition happen?
- ***Who*** is responsible for the energy transition and roadmap?
- ***When*** should the transition begin, and what are the mid- and long-term timelines?
- ***Where*** should the energy transition begin?
- ***How*** will the transition happen?

The engagement of all relevant stakeholder groups is also important at this phase. The final output of this process must answer the question of the impact the roadmap will have on the energy transition and resilience in the community. Various factors can contribute to a robust visioning process, including citizens' interests, economic, social and environmental concerns, and the consideration of risk.

1.2 Institutional arrangement formation

Back to framework

Institutional arrangements include the local government's **organizational structures** as well as the **informal norms** that are in place for delegating and undertaking its policy or strategic work.

They also include the set of agreements on the **division of the respective roles and responsibilities** of entities involved in the collection, compilation, and dissemination of data and information on the energy system roadmap (UN 2017).

Institutional arrangements ensure that data usability, compliance, and information meet the needs of users, follow quality standards, and are compiled and disseminated in the most efficient way. This arrangement includes linkages within and among organizations at the local, state/provincial, and national levels, and between governmental and non-governmental entities, including the local community and private sector.

It serves as the foundation for **effective process management**, from the identification of data sources to the dissemination of results, and for promoting communication between the various stakeholders and institutions involved. Institutional arrangements include the involved and responsible organizations, their human resources, funding, equipment and supplies, leadership, effectiveness, and the communication links between and among organizations.

1.3 Stakeholder mapping

Back to framework

Stakeholder mapping is the identification of all stakeholders directly or indirectly influenced by the 100% renewable energy roadmap and the energy transition. This step includes the analysis of various **stakeholder criteria and their expectations**, **prioritizing** as needed, and **engaging** them in the process.

It is important to identify a **diverse range** of stakeholders, their different expectations, the complexity of their relationships with each other, and a communication model or format that can work for various stakeholders.

Some examples of important tools used for stakeholder analysis and mapping include **brainstorming**, **questionnaires**, **surveys**, and **meetings**. Stakeholders can include local government departments and officials, the private sector, financing institutions, civil society, non-governmental organizations and others.

1.4 Core teams identification

Back to framework

Core teams are cross-functional teams with the **role, responsibility and authority** for the delivery of the 100% renewable energy roadmap, as well as inter-sectoral coordination. This process is on par with stakeholder mapping and the setup of institutional arrangements.

Given the fact that the transition towards 100% renewable energy will involve significant changes across multiple sectors, it is essential to bring together local teams with **sector-specific expertise**. This can allow smoother **working relationships** on the ground, as well as identifying **synergies** across sectors, allowing multiple challenges to be tackled simultaneously.

2. BASELINE ASSESSMENT

2.0 Data collection

Back to framework

After the scope and vision statement for the 100% renewable energy roadmap have been defined, the next phase begins with **data collection and an assessment** of the current energy system. It is then followed by energy systems modeling and scenario development.

The baseline assessment process includes the collection of datasets relating to **energy demand**, **energy supply or generation**, energy resources and **efficiency**, the **cost of energy**, the **socio-economic situation**, data on **policies**, and **environmental or other externalities**.

The objective of the baseline assessment, and subsequently the modeling, is to highlight existing technology, resources, policies, and investment sources, and identify what other elements are needed to achieve the strategic goal, while considering risk factors such as stranded assets. Stakeholder engagement should take place continuously at this stage to remain relevant with the local context (Williams and Waisman 2017).

2.1 Energy demand data

Back to framework

One of the first and most important processes of this phase is the collection of data related to energy demand.

The local government needs to identify all **energy-consuming sectors** and the **amount of energy** consumed, as well as the **types of fuels** or energy carriers that provide this energy. The scope of energy demand includes:

- Energy consumption by sector (residential, transport, industrial, agricultural);
- Heating and cooling demand;
- Transportation fuel demand;
- Electricity demand (ideally high resolution, such as hourly or half-hourly);
- Other fuel consumption data, for example hydrogen, biomass and solid fuels (firewood), depending on the local context

2.2 Existing supply and generation data

Back to framework

The identification of current sources of energy supply, in addition to energy demand, forms the basis for scenario formulation and acts as a baseline for the energy transition. It provides a picture of how demand is being met at present, the **type of fuels or energy carriers** used, and how this supply can be transitioned towards being derived from renewable sources.

This data can include, but is not limited to:

- Information on power generation plants, including capacity, types of fuel used and plant efficiencies
- Own consumption involved in generating energy
- Electrical grid capacity
- Import of petroleum products and other primary energy sources

Information on the status of current power plants also provides more insight into the **useful life** of the existing plants, and **timelines** involved in switching to renewable sources of generation, as well as the **feasibility** of switching to renewable feed sources.

2.3 Energy efficiency data

Back to framework

Energy efficiency is a key consideration for a 100% RE roadmap. National adaptation needs and climate change mitigation strategies are centered on improving **energy efficiency**, reducing **energy intensity**, and reducing carbon dioxide emissions.

Renewable energy development as well as energy efficiency measures constitute important pillars of **climate change mitigation**. Assessing their potential is key to setting ambitious climate neutrality targets, divesting from the fossil-fuel sector, and investing in an energy system with lower carbon dioxide emissions.

Examples of energy efficiency data include, but are not limited to:
- Electricity grid losses;
- Energy fuel conversion losses;
- Energy end-user efficiency data such as residential heat and electricity savings potential;
- Retrofitting needs;
- The effect of switching to more efficient technologies, such as LED bulbs.

2.4 Geographical information systems data

Back to framework

Geographical information system (GIS) data has been instrumental in the area of energy planning at national, regional, and local levels. The GIS mapping process considers various factors such as **geographical location**, as well as **environmental, economic, and social constraints** to provide information about **suitable locations** for RE plants and the **technical potential** of energy resources that can be harnessed.

The application of GIS data in sustainable urban planning and development supports the use of **visually appealing** geographic information to enhance the understanding of the stakeholder. It also aids management, as well as more informed political, economic, financial and investment-related decision-making.

GIS data can be used in order to **quantify** how much renewable resource potential is available, as well as to find **physical locations** within the community's administrative boundary where renewable energy plants can be located.

Examples of GIS data include **wind speed data**, **solar radiation data** (PVout, GHI, DNI), weather data (precipitation, humidity, temperature), hydrology data (rivers, streams), topographic data (SRTM – DEM), land cover, population density data, building footprint, facility maps, etc.

2.5 Energy costs data

Back to framework

Cost data collection involves the linkage between the energy transition, **finance**, and **investment options**, and the **economic outcome** of the transition. Cost data requires **energy demand data**. Sample data includes, but is not limited to:

- Electricity tariffs
- Costs of fuel sources
- Energy generation costs
- Cost of infrastructure
- Power plant capital costs
- Costs of wind and solar power, and storage
- Operation and maintenance costs of power plants

2. BASELINE ASSESSMENT

2.6 Socio-economic data

Back to framework

This process includes the collection of data that relates the energy transition to **socio-economic objectives**. This set of data can include for example the local consumer population, and the changes in energy consumption with changes in population over time.

It also includes the amount of money spent on energy relative to the income level. The type of data the local government can collect includes **population growth**, **income levels**, **health indicators**, and **local conditions**, and **societal aspirations**.

Given that a local region's population will be impacted by a transformation of the energy system, these data are important in order to identify solutions that are **feasible** to implement, **acceptable** to the broader population to the maximum extent, and most importantly are **affordable**. In addition, multiple socio-economic challenges are related to energy use, for example clean cooking. Gathering data on these can also allow them to be addressed in sync with a greater uptake of renewable sources.

2.7 Environmental and other externalities

Back to framework

At the global level, energy consumption-related emissions make up about two-thirds of total greenhouse gas emissions (IEA 2020), implying that emissions reduction from the energy system is one of the key pillars of climate change mitigation strategies.

The objective of environmental data collection is for local governments and authorities to effectively analyze and quantify the **environmental impact** of their current energy consumption in terms of **CO_2 and other greenhouse gas (GHG) emissions**. This process might also include a **literature review** to identify the volume of emissions per source of energy, and the efficiency of various conversion technologies.

Other externalities can include the impact on **air pollution**, **water usage**, **land use change**, the impact on **biodiversity**, among others.

2.8 Policy data

Back to framework

This step refers to the collection of all **policy-related data** and information that directly or indirectly affects the renewable energy transition. This impact can be in terms of **project development, entry requirements, financing, tariff, subsidy structures, governance**, and so on. Policy-related questions include, but are not limited to:

- What are the **current policy goals** related to renewable energy development?
- What are **other related policies** in finance, environment, or project development that might affect RE development?

Robust policy data can be qualitative, and could also include key metrics to measure the performance of current policies and their effect on the energy transition.

2.9 Synthesized data, assumptions & constraints

Back to framework

The data collection process has some natural limitations, due to capacity constraints, lack of accurate measures and so on. Such constraints in the process can lead to the adoption of certain assumptions.

In certain cases, the local government can then use synthesized data, either regional or national, or through **extrapolation of available data** to suit local conditions. Careful consideration must be given to the type of data used and how the **assumptions** that have gone in might affect the credibility of the result.

All assumptions must be documented and may be revised.

Examples of this synthesized data include the use of the national average for local energy demand estimation or extraction of local data from satellite or synthesized data.

3.0 Analyze and develop

Back to framework

A real-world energy system may contain a large number of variables, constants, functions, or situations that cannot be represented mathematically. A **model** categorizes similar variables, simplifies them through aggregation, makes rational assumptions, puts limits by assigning constraints, and applies best-fit mathematical equations to depict the real-world system as precisely as possible. According to Poudyal and Paatero (2013), a model helps to understand the problem and to investigate the solutions. An energy model therefore helps in **organizing data and information**, **finding optimal solutions** and resource allocation, and even **forecasting future scenarios**. It serves as a platform for consistent hypothesis testing, and helps to **communicate** assumptions among the various decision-makers and stakeholders. Inputs can include, but are not limited to:

- Demand data: residential, industrial, commercial, agricultural, transportation sectors, etc.
- Cost data: investment, operation & maintenance, fuel, CO_2, etc.
- Generation data: conventional and renewable generation
- Energy storage: pumped hydro, batteries, hydrogen, etc.
- Transmission data: cost of transmission/distribution, losses etc.
- Energy commodities: electricity, heat, hydrogen, etc.
- Demand-side management: energy efficiency, demand response etc.
- Emissions data: CO_2, NO_2, NO, CH_4, etc.

Commonly used modeling software includes spreadsheets, Python-based open-source frameworks, web-based applications, and other enterprise software.

3. MODELING AND SCENARIO DEVELOPMENT

3.1 Energy demand & supply assessment

Back to framework

This is the quantitative estimation of the **amount of energy** consumed, and the **rate** at which it is consumed over a given time period.

Given that the initial data collection has already been completed, the outputs of the previous phase act as inputs for this one. These include, but are not limited to:

- Electricity demand (incl. high resolution such as hourly or half-hourly),
- Energy consumption by sector (residential, transport, industrial, etc.),
- Heating and cooling demand,
- Transportation fuel demand,
- Other fuel consumption data,
- Socio-economic data (population size, household size etc.)

Through processing this data through **descriptive statistics, trend analysis, predictive analysis** and so on, certain outputs are produced such as information on current demand, **projected future demand** based on certain assumptions, as well as any constraints that can be identified.

3.2 Energy efficiency assessment

Back to framework

Energy efficiency is the first level of carbon reduction and it directly impacts the **quantity of energy demand**. Energy efficiency assessment is the analysis of energy efficiency-related data across all energy-consuming sectors. This information includes the type of housing and energy efficiency potential such as **retrofitting potential, LED lighting, green buildings, use of efficient devices**, etc.

Most scenarios for reaching 100% renewable energy involve some level of increased efficiency. Greater efficiency can reduce the need for new **capacity** for renewable generation, reducing the **overall cost** of the transition. It can also help achieve other climate-related goals such as **reducing carbon dioxide emissions.**

3. MODELING AND SCENARIO DEVELOPMENT

3.3 Geographical information system (GIS) mapping

Back to framework

In this step, data gathered through GIS such as **wind speed, global horizontal irradiance, photovoltaic output, precipitation, elevation, land use, hydrological data, geological data**, among others, act as inputs.

Through methods such as site suitability assessments, certain outputs are produced, including:

- Locations of suitable sites for renewable energy installations
- RE resource potential (wind, solar, hydro, biomass, geothermal, tidal, etc.)

Some examples of GIS mapping tools include ArcGIS, QGIS, Python, R, Google Maps, and Open Street Maps.

The GIS mapping stage is not final; it is the first step towards evaluation potential locations for renewable generation, and can help identify the potential sources that can be used from within and around the local region. It is then followed by more detailed analysis, including **pre-feasibility and feasibility studies, environmental impact assessments** and so on.

3.4 Energy costs assessment

Back to framework

This step involves the analysis of cost data, including the cost of different **energy sources**, **trends in fuel prices**, and how they relate to other socio-economic data. It also includes the **forecast of future energy costs** based on other economic indicators such as GDP growth.

Present and estimated future costs of various energy sources can impact the parameters of the roadmap scenario. While there is a high degree of uncertainty involved regarding future costs, **general trends** can be used to ascertain what types of technologies are feasible and are likely to remain so.

This step can also be used to anticipate the impact of future costs such as a **carbon price**, which in the long term is likely to make hydrocarbons and other carbon-intensive sources less feasible compared to low-to-zero carbon sources. In such cases, renewables may not only be the most climate-friendly option, but also the most cost-effective.

3.5 Socio-economic assessment

Back to framework

This step involves the analysis of the socio-economic situation, and past and future trends. This is important given the strong correlation between such indicators, and the energy system. Data such as the size of the **population**, its likely **growth rate**, **income** levels, energy **consumption** basket and so on are all likely to impact future projections. All these variables are likely to affect future energy demand, land use patterns, finance and investment opportunities, community acceptance of certain pathways, among others.

3.6 Impact assessment of the energy system

Back to framework

This step involves an analysis of the likely impacts of the energy system on various environmental indicators, and other indirect impacts. This can include **life-cycle analysis (LCA)** of various renewable energy sources in order to choose an option with the lowest overall emissions throughout the lifetime of the project. Other factors to consider include the **generation of waste**, and the recycling of various elements such as photovoltaic panels or wind turbine blades.

Other impacts such as the effect on **biodiversity** due to large renewable installations can also be quantified, which can affect the feasibility of certain options.

4. ROADMAP AND IMPLEMENTATION

4.0 Plan and implement

Back to framework

Following from the previous stage, a **final energy model** is produced after feedback and consultation with the various stakeholders involved. Depending on the type of model—simulation, optimization, or equilibrium—an energy model can serve as a platform for **scenario formulation**, **operational decision support**, **investment decision support**, and a **test** of assumptions, policies, or constraints. The energy model must also be **consistent, robust, flexible, and transparent**.

A **consistent** model is easily understandable by users as they become familiar with both the model's purpose and content.

Secondly, **robustness** ensures that a model is mathematically accurate and free from all forms of errors. To further verify this characteristic, a model may be subjected to a third-party audit for error checks.

Model **flexibility** is the ability to change various assumptions or input parameters to see how the changes affect various outputs. Flexibility criteria are important for an energy model with some parameters that have a high degree of uncertainty.

Lastly, **transparency** ensures that the model is clear, concise, and fit-for-purpose.

In the case of roadmap development, the energy model forms the basis of a **future needs assessment, land use planning, impact assessments**, and for identifying gaps in policies. All these can be addressed through **targeted interventions**, although the roadmap document itself provides an overall **strategy and framework.**

4.1 Finance and investment needs

Back to framework

After energy model development and scenario formulation, there is a need for a **financial and investment plan**. This plan can identify potential **sources of financing**, potential **partners**, and the **amount of investment** required in order to undertake bankable projects in the local region. The plan and projects will need to be consistent with the **current or recommended policies** in order to achieve the target of 100% renewable energy use.

4.2 Future energy scenario land use

Back to framework

This step in the analysis is a quantitative assessment of the area of **land that will be directly or indirectly impacted** by the future energy system, and the development of renewable energy sources. This analysis will also have to take into account the **growth patterns** of the region, **biodiversity spots** and other protected areas, the potential of **barren and fallow land**, etc. It can help with **improved planning**, such as avoiding areas that are likely to see the impacts of climate change over the coming years, or even using them for other suitable purposes.

4.3 Future energy scenario economic impact

Back to framework

This step identifies the detailed social and economic impacts of the modeled scenario. This can include, for example, the predicted **cost of the future energy system** and its impact on other socio-economic parameters such as **income levels.**

4.4 Other future energy scenario impacts

Back to framework

This step involves the analysis of the direct and indirect impacts of the energy scenario on various indicators, including for example the achievement of the United Nations **Sustainable Development Goals**. It also involves an emissions impact assessment in terms of likely **CO_2 and other greenhouse gas (GHG)** emissions. Aligning the 100% renewable energy roadmap with broader national- or international-level climate goals can lead to greater efficiency in planning and implementation, as well as greater access to financing from motivated parties.

4.5 Policy gap analysis

Back to framework

The policy and market structure plays a crucial role in the deployment of renewable energy. One of the main requirements of renewable energy policy is the consideration of **long-term impacts**, and how policies can **stimulate market growth**. Therefore, an enabling policy environment must encourage investors, developers, and users to adopt renewable technologies and adapt to the **changing dynamics** of the energy market.

Policy gap analysis begins by **benchmarking** the current energy situation and pinpointing areas where policies fall short of the requirement for achieving 100% renewable energy in future energy scenarios (FES). This analysis also answers the questions of the required **legal and institutional framework** required to achieve the 100% renewable scenario, as well as other mid- to long-term objectives.

Gap analysis tools include questionnaires, focus groups, nominal groups, or benchmarking policy frameworks of other local governments.

5. 100% RENEWABLE ENERGY ROADMAP

5.0 Final roadmap document

Back to framework

A roadmap document defines the overarching strategic objectives and captures critical steps as a pathway towards the achievement of certain targets, such as 100% renewable energy. Albright (2021) defines a roadmap as a link between strategies and future actions, including a time-dependent plan for all required capabilities and technologies.

A 100% renewable energy roadmap is an integrated strategy consisting of political, economic, financial, and stakeholder engagement processes. Four integral **enablers** include: **i) policy, ii) market structure, iii) investment and finance, and iv) infrastructure** (Pricewaterhouse Coopers, 2010). An effective roadmap must be consistent with local and national strategies, and be achievable within the constraints of available technology, investment needs, and other socio-economic constraints. Wehner et al. (2017), decompose the roadmap enablers into **twelve interacting systems**:

1. *Power market systems* or *structure;*
2. *Renewable energy support, and development;*
3. *Renewable energy resource assessment*
4. *Stakeholders' engagement;*
5. *Sector coupling;*
6. *Cost of energy systems;*
7. *Energy policy and regulations;*
8. *Financial support;*
9. *Institutional and capacity development;*
10. *Energy infrastructure and grid integration;*
11. *National policy targets;*
12. *Technical and cost assessment of energy systems.*

5.0 Final roadmap document (cont.)

Back to framework

Based on the above enablers and the interacting systems, the critical success factors of a 100% renewables roadmap can be summarized as:

- policy measures,
- technology requirements,
- costs and financing needs, and
- capacity building

These crucial elements must be considered or addressed in the development of the roadmap. A robust roadmap must also integrate various interacting systems and elements by analyzing the interrelationships between various sectors.

Another feature of the 100% renewable energy roadmap framework is its **applicability** to certain sectors or users according to the context. For example, a national 100% renewables framework for companies will be different from a framework for a local government, or for sector-specific energy transition roadmaps.

Therefore, when adopting an strategy towards an energy transition, the limitation of that strategy based on applicability should be considered. The ability of users to **customize strategies** to various jurisdictions and with unique geographical, political, and socio-economic contexts is very important. This, therefore, describes one of the attributes of a good strategy i.e. **flexibility**.

5.0 Final roadmap document (cont.)

Back to framework

Principles and success criteria:

a. Citizen and climate focus

The main objective of a 100% renewable energy roadmap is to improve the social and economic welfare of the citizens while mitigating the impact of climate change. According to Williams and Waisman (2017), making socio-economic goals an integral part of the roadmap development process ensures that the pathways to achieve a low-carbon transition are mutually inclusive with desired socio-economic outcomes. Examples of socio-economic objectives embedded in the 100% renewables roadmap include income levels, cost of energy, electricity tariffs, health and environmental indicators, local conditions, and other societal aspirations.

b. Stakeholder engagement

One of the important criteria of success for a mid- or long-term plan is the engagement of all relevant stakeholders. A roadmap requires the identification of all relevant stakeholders and getting all stakeholders' buy-in either through dialogues, town hall meetings, or other means. Stakeholder communication involves speaking the language of various stakeholder groups such as legislators, taxpayers, investors, journalists, consumers, and voters to relate the roadmap and energy transition to their direct concerns beyond mitigation such as development, income, and health impact (Williams and Waisman 2017).

5.0 Final roadmap document (cont.)

Back to framework

c. Process and systems approach

In a process and systems approach, the roadmap is interconnected with energy consumption sectors such as household, industry, commercial and agriculture, and various end usage or final energy consumptions. For a roadmap to be successfully developed and implemented, it must combine various aspects such as technical solutions, economic solutions, human behavioral change, policy, and other aspects of society. The desired result is therefore achieved more efficiently when activities, sectors, and related resources are managed as interconnected systems and processes.

d. Science-based decision making

Effective decisions are based on the analysis of data and information. Therefore, by using different modeling approaches and scenario formulations, a roadmap ensures that political decisions are informed according to a scientific approach, and therefore unlikely to change drastically with changes in political leadership.

e. Leadership

Leaders establish a unity of purpose and a direction for the community or organization. They are responsible for creating and maintaining the environment in which different sectors, institutions, and citizens can cooperated in achieving the roadmap's objectives. Leaders create the vision, strategic direction, and manage the needs and expectations of all stakeholders. Leaders at decision or policy levels need to show commitment through policy formulation, creation of core teams, vision and scope statement, and driving the roadmap implementation.

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