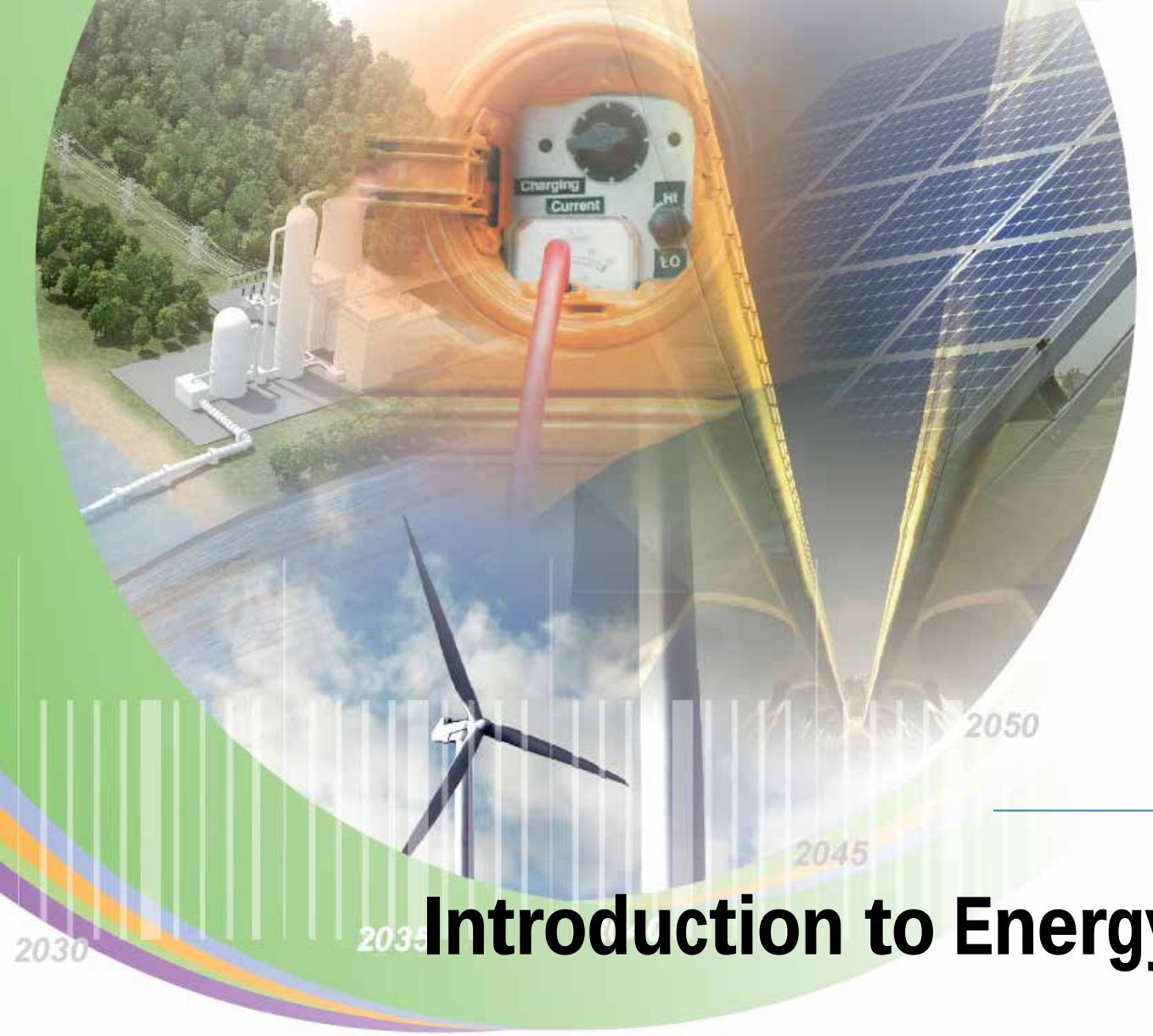


Introduction to Energy Technology Roadmaps

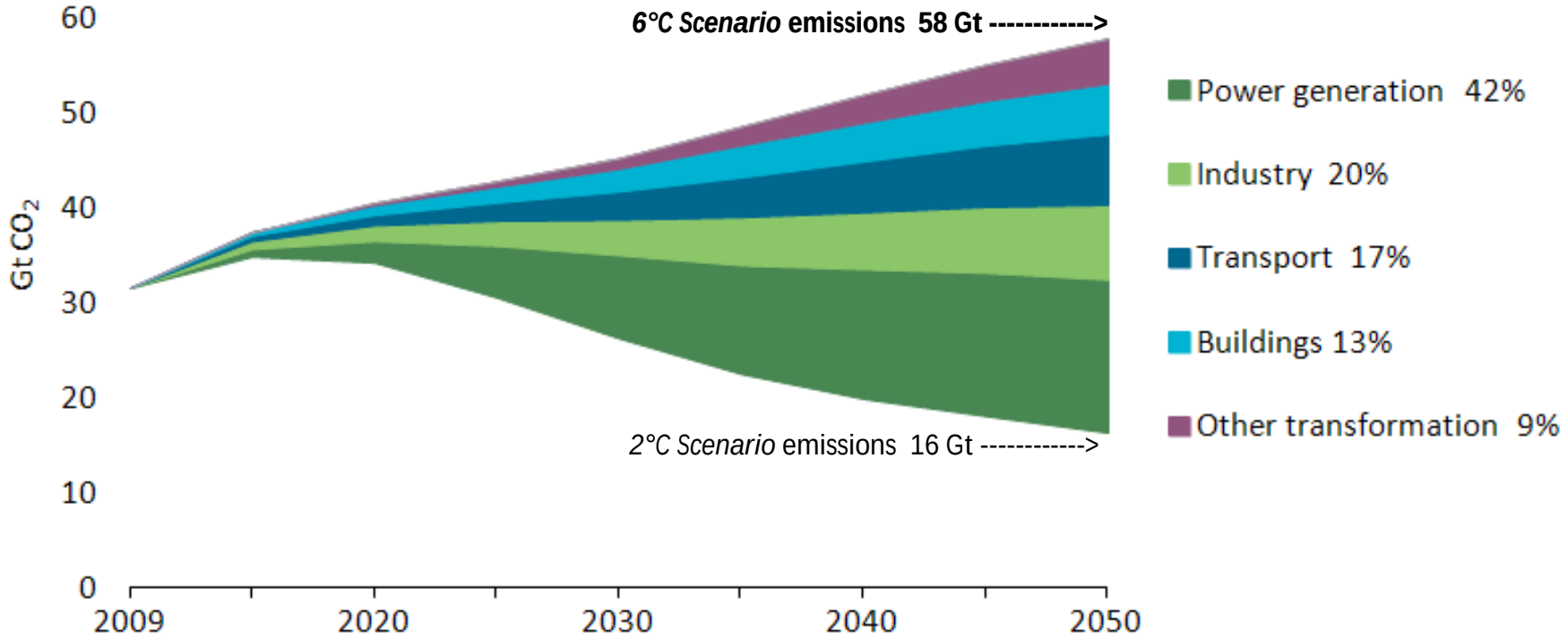
Energy technology roadmaps

International Energy Agency

Overview

- Global context for energy technology roadmaps
- About technology roadmaps
- How-to-guide and roadmap process
- Examples of IEA roadmaps

Key technologies for reducing global CO_2 emissions



Source: Energy Technology Perspectives 2012

- 6°C Scenario – business-as-usual; no adoption of new energy and climate policies
- 2°C Scenario – energy-related CO_2-emissions halved by 2050 through CO_2-price and strong policies

ABOUT TECHNOLOGY ROADMAPS

IEA roadmap definition

"A technology roadmap is a dynamic set of technical, policy, legal, financial, market & organizational requirements identified by all stakeholders involved in its development. The effort shall lead to improved and enhanced sharing and collaboration of all related technology-specific RDD&D information among participants.

The goal is to accelerate the overall RDD&D process in order to deliver an earlier uptake of the specific energy technology into the marketplace".

The IEA roadmap approach

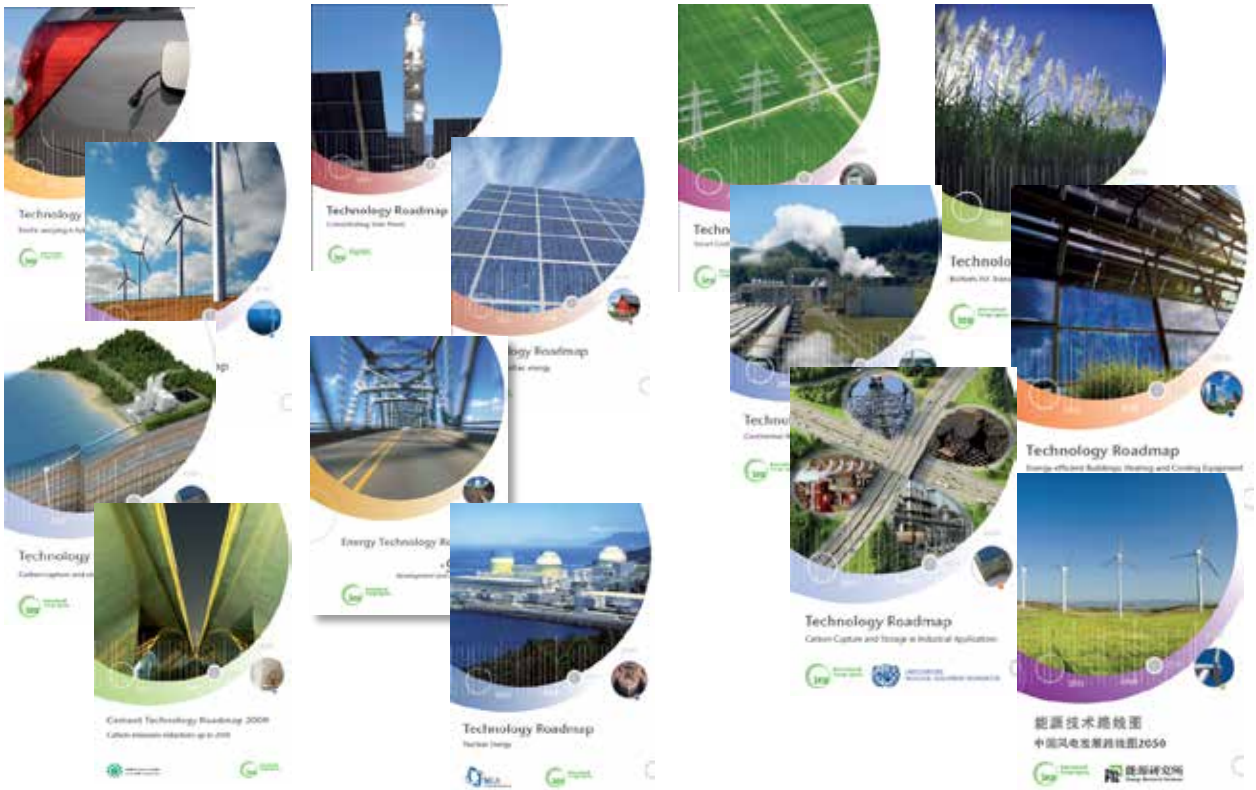
- Engage cross-section of stakeholders
- Identify a baseline – where is technology today?
- Use *ETP* 2 degree scenario (2DS) results for deployment pathway to 2050
- Identify barriers – technical, regulatory, policy, financial, public acceptance
- Develop implementation action items for stakeholders

Technology roadmaps provide answers

- **Where is technology today?**
  - GW installed capacity/kWh of savings
  - Leading countries/regions
  - Cost, efficiency
- **What is the deployment pathway needed to achieve 2050 goals?**
  - Use IEA Energy Technology Perspectives BLUE Map scenarios
- **What are the priority near-term actions?**
  - R&D gaps and how to fill them
  - Identify barriers and obstacles and how to overcome
  - Market requirements and policy needs
  - Technology diffusion/transfer and international collaboration needs

Technology roadmaps status

2009 **2010** **2011**



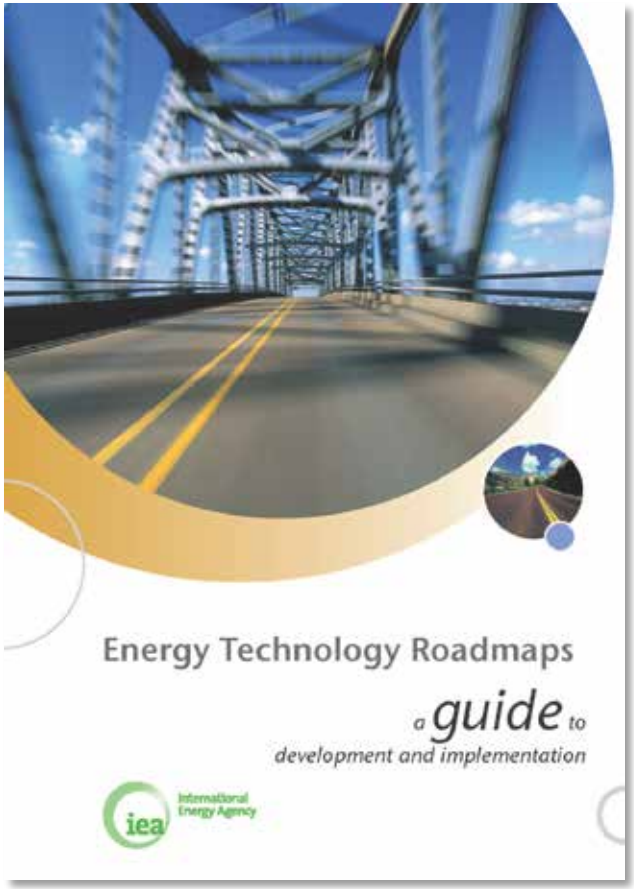
2012 / 2013

- **Bioenergy for heat and power**
- **Vehicle Fuel Economy**
- **Solar heating & cooling**
- **High efficiency, low emissions coal**
- **Chemical catalysis**
- **Hydropower**
- **Energy efficient building envelopes**

HOW-TO GUIDE

Energy technology roadmaps guide

- Guide published in 2010 by IEA
  - Understanding roadmaps
  - Roadmap development process
  - Tailoring the roadmap process

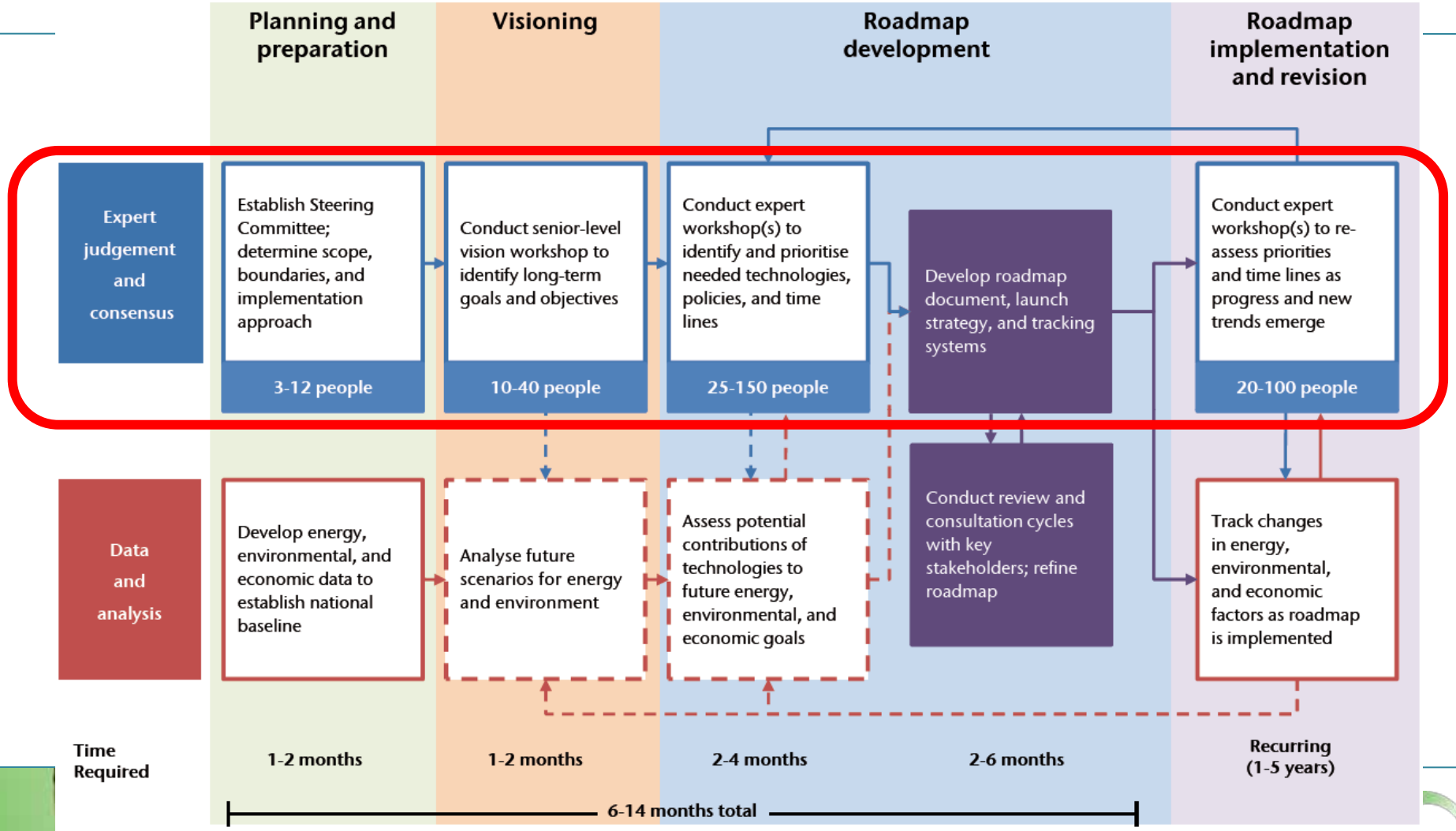


http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2291

Roadmap logic

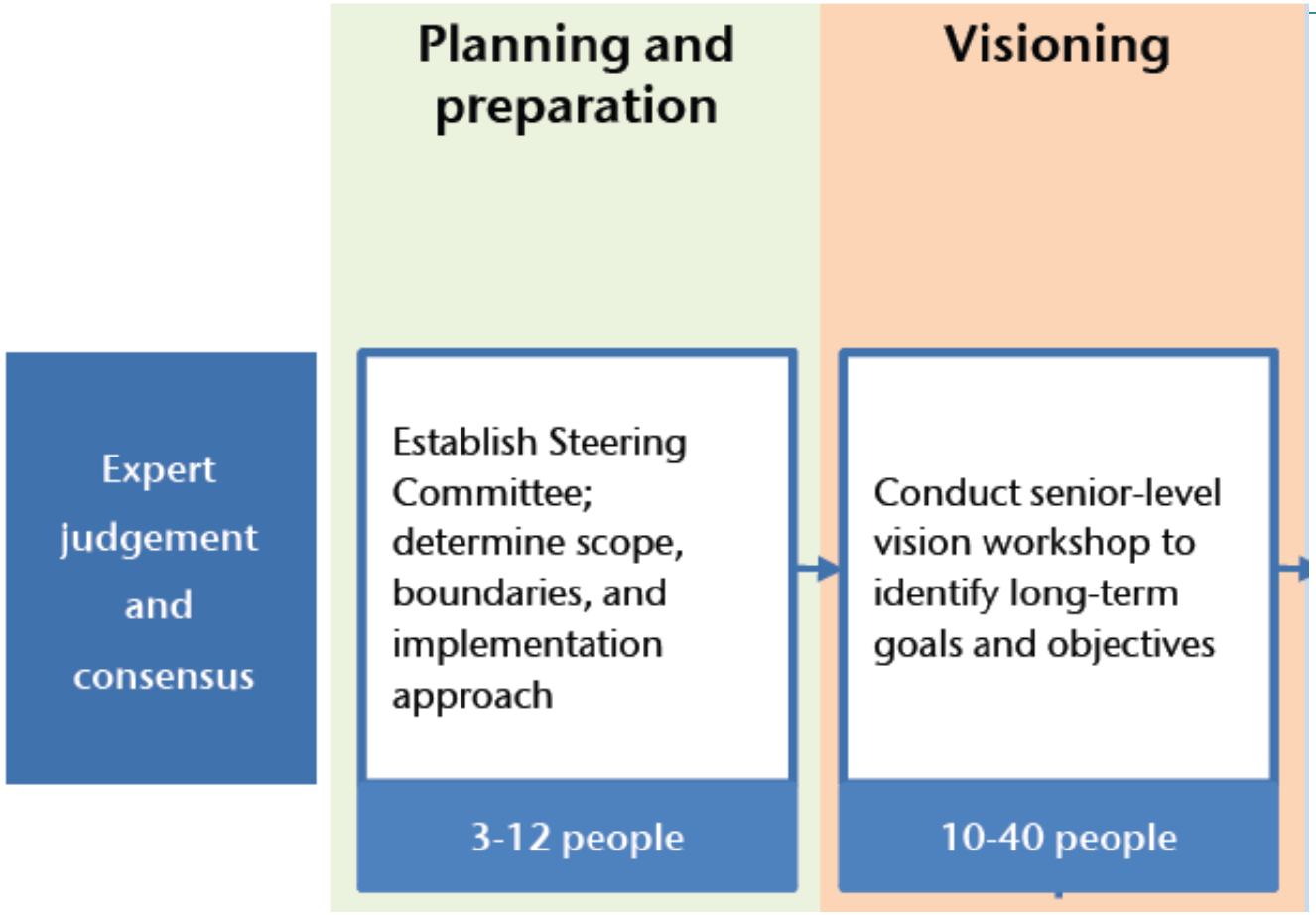
- Goal to achieve
- Milestones to be met
- Gaps to be filled
- Actions to overcome gaps and barriers
- What and when things need to be achieved

Roadmap process outline



Note: Dotted lines indicate optional steps, based on analysis capabilities and resources.

Roadmap process outline



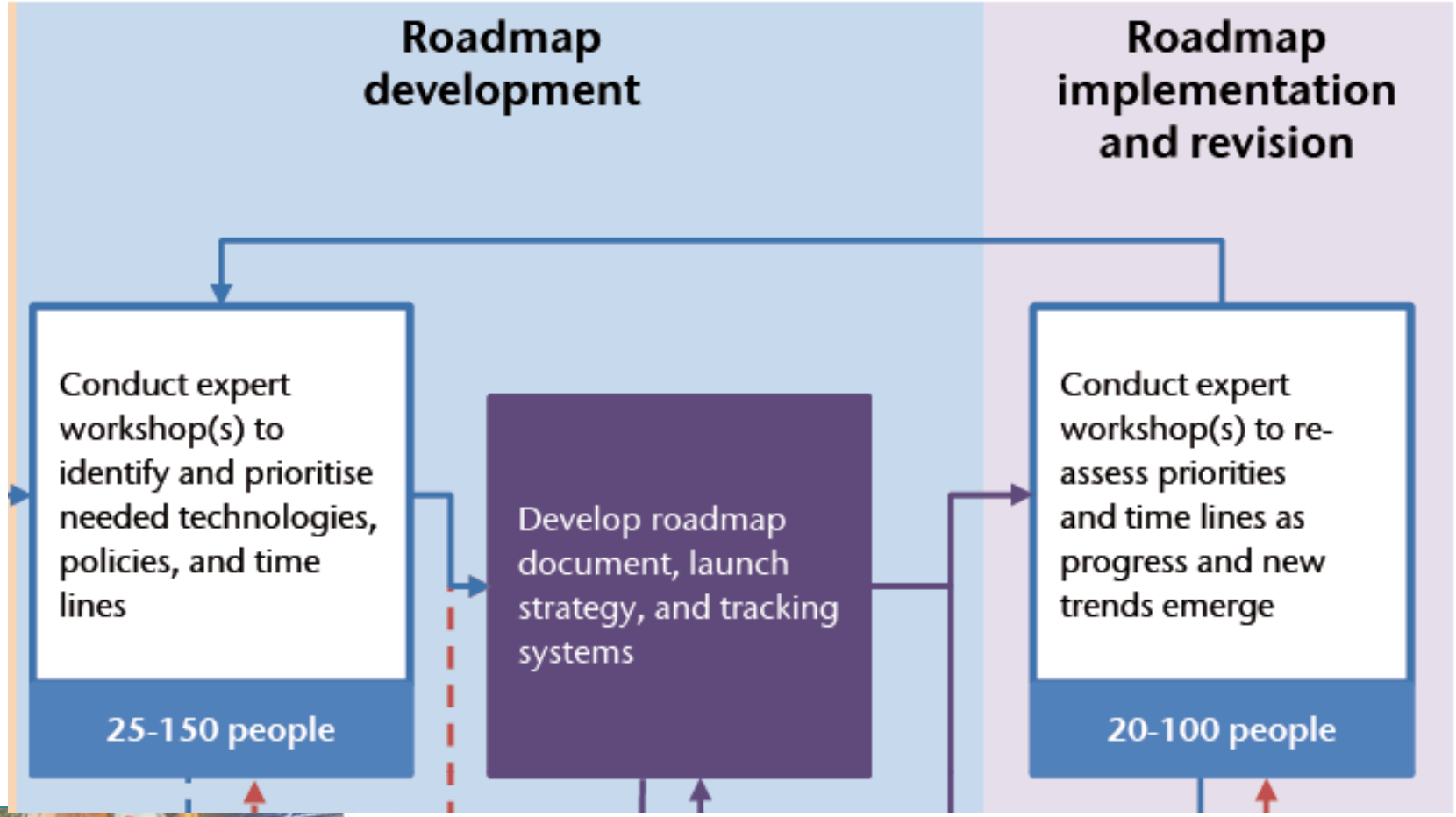
Planning and preparation

- Who will set roadmap goals? Who will be responsible for developing the roadmap?
- How much time is available to develop the roadmap? What is the timeframe of the roadmap?
- What skills and tools will be needed?
- Are appropriate data and analytic tools available?
- Are sufficient personnel available to manage and implement the roadmap development process?

Planning and preparation phase

- Ensure leadership commitment
- Appoint a steering committee
- Develop a statement of purpose and scope
- Conduct baseline research
  - Technologies, markets, policies
- Select stakeholders and experts

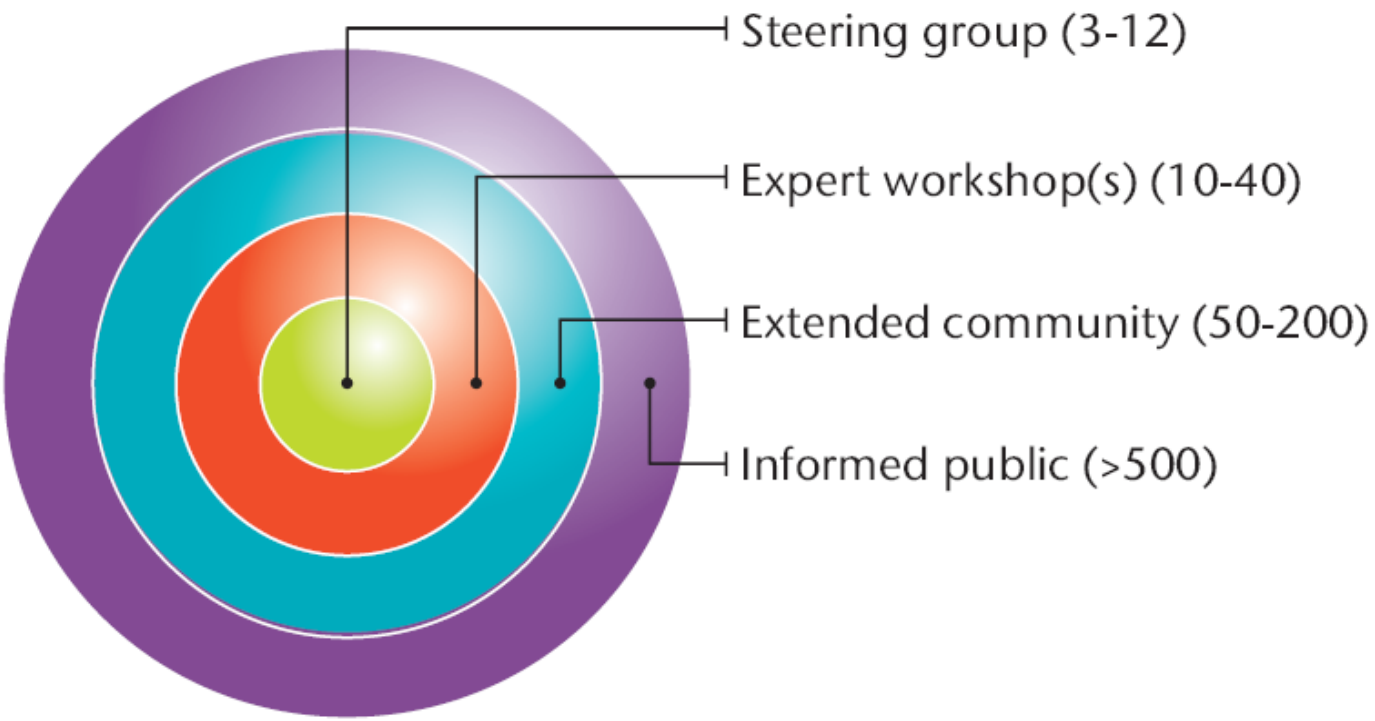
Roadmap process outline



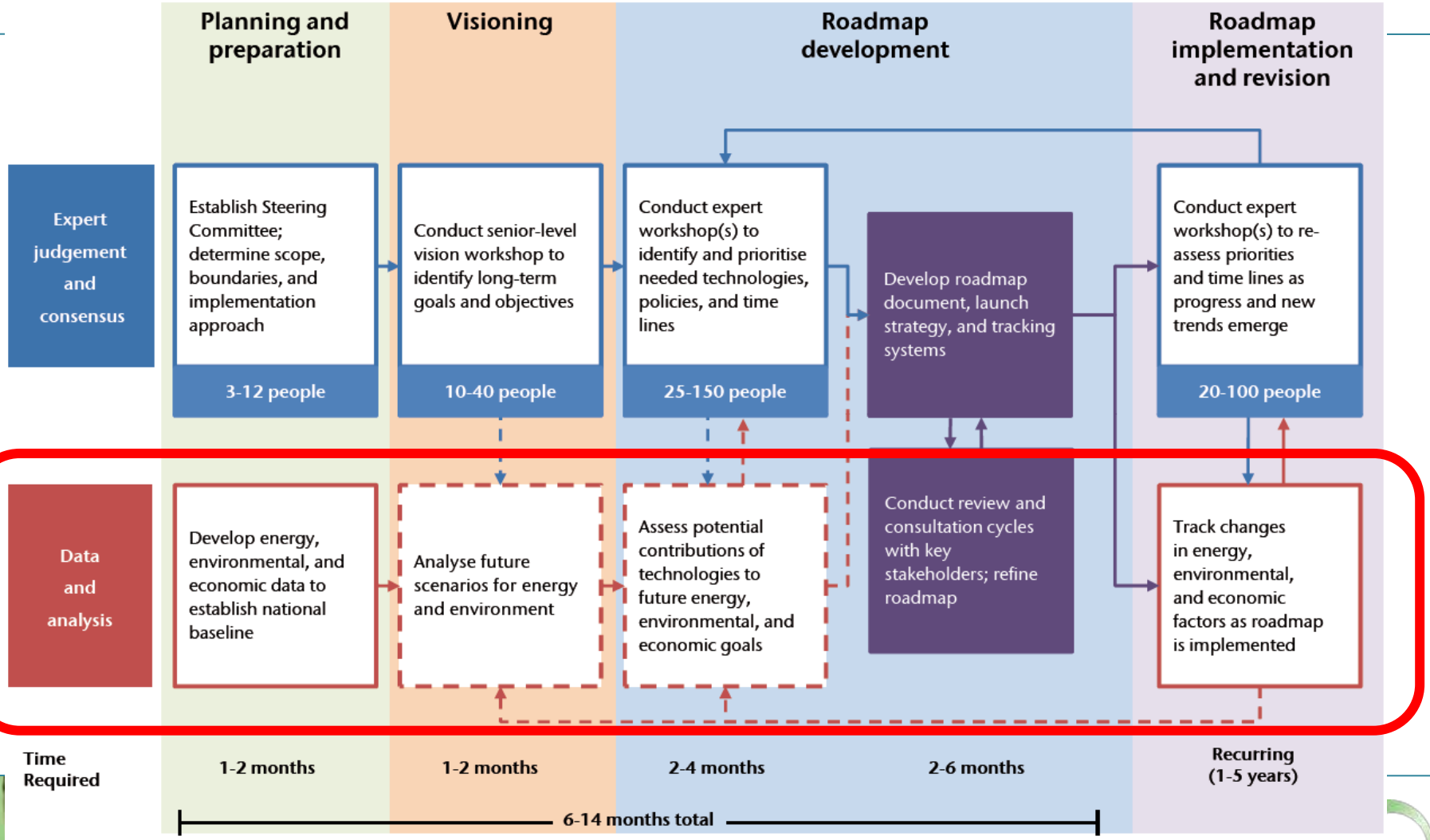
Expert judgment and consensus: roadmap workshops

- Structured vision and technology roadmap workshops can:
  - Build consensus on goals and targets
  - Evaluate and verify assumptions
  - Identify technical and institutional barriers
  - Define alternative technology pathways
  - Develop implementation strategies and priorities

Managing engagement

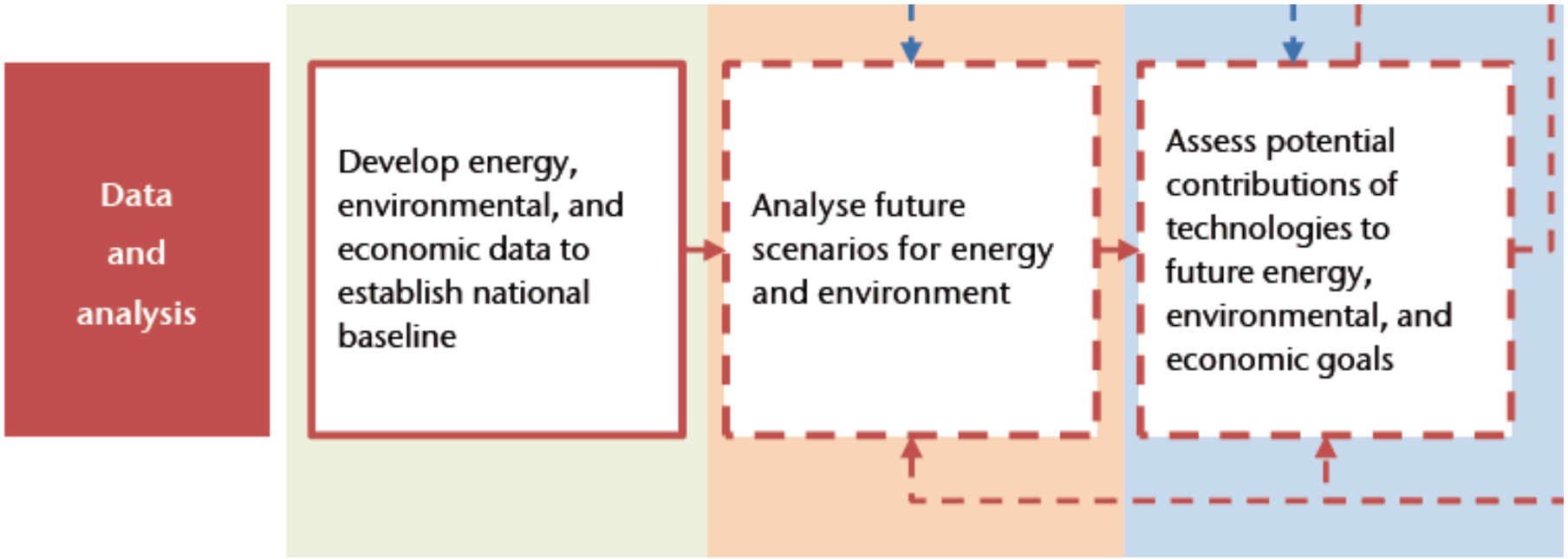


Roadmap process outline



Note: Dotted lines indicate optional steps, based on analysis capabilities and resources.

Roadmap process outline



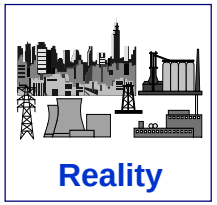
Baseline data

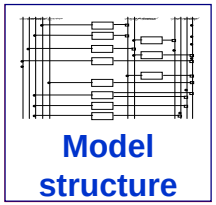
Situation analysis of key factors:

- Technologies:
  - Current status of costs and performance
  - Technology readiness
  - Market penetration and limitations
- Markets:
  - Suppliers, distributors and customers
  - Energy characteristics (production, delivery, storage and consumption)
  - Environmental impacts (air, water and land impacts)
- Public policies:
  - Current status and requirements of relevant, existing laws and regulations

Model-based scenario analysis

- Representation of relevant aspects in real-world system:
  - Model scope depending on technology area
  - Several models may be required


Reality


Model structure

- Typically quantitative formulation with balance between accuracy and manageability:
  - Complexity may vary: from simulation-based spreadsheet models to more elaborate cost optimization models

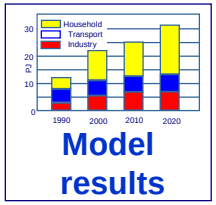
$$P_{BHKW\_S} = h_{BHKW} \times P_{Coal\_BHKW}$$
$$O_{BHKW\_CO_2} = e \times P_{Coal\_BHKW}$$
$$Q_{BHKW\_H} = h_{2\_BHKW} \times P_{Coal\_BHKW}$$

Mathematical description

+


Data

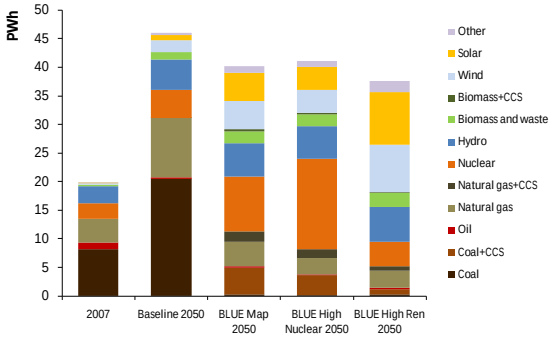
- Exploring possible future technology deployment pathways through scenarios

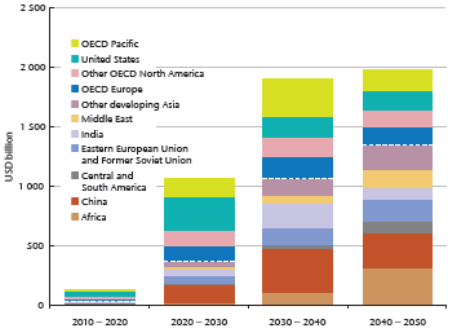


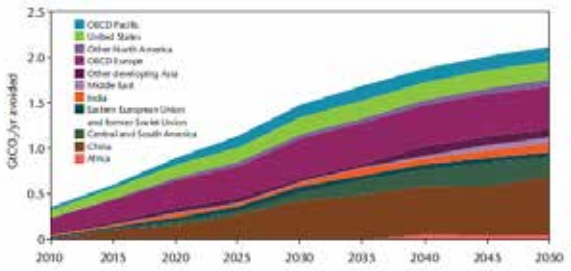
Model results

Example: results of power sector model analysis

- **Future power generation mix and capacities**
- **Fuel demand**
- **Environmental impacts**
- **Long-term electricity prices**
- **Investment needs**
- **Effect of policy instruments**
- **Uncertainty analysis**







Benefits of scenario analysis

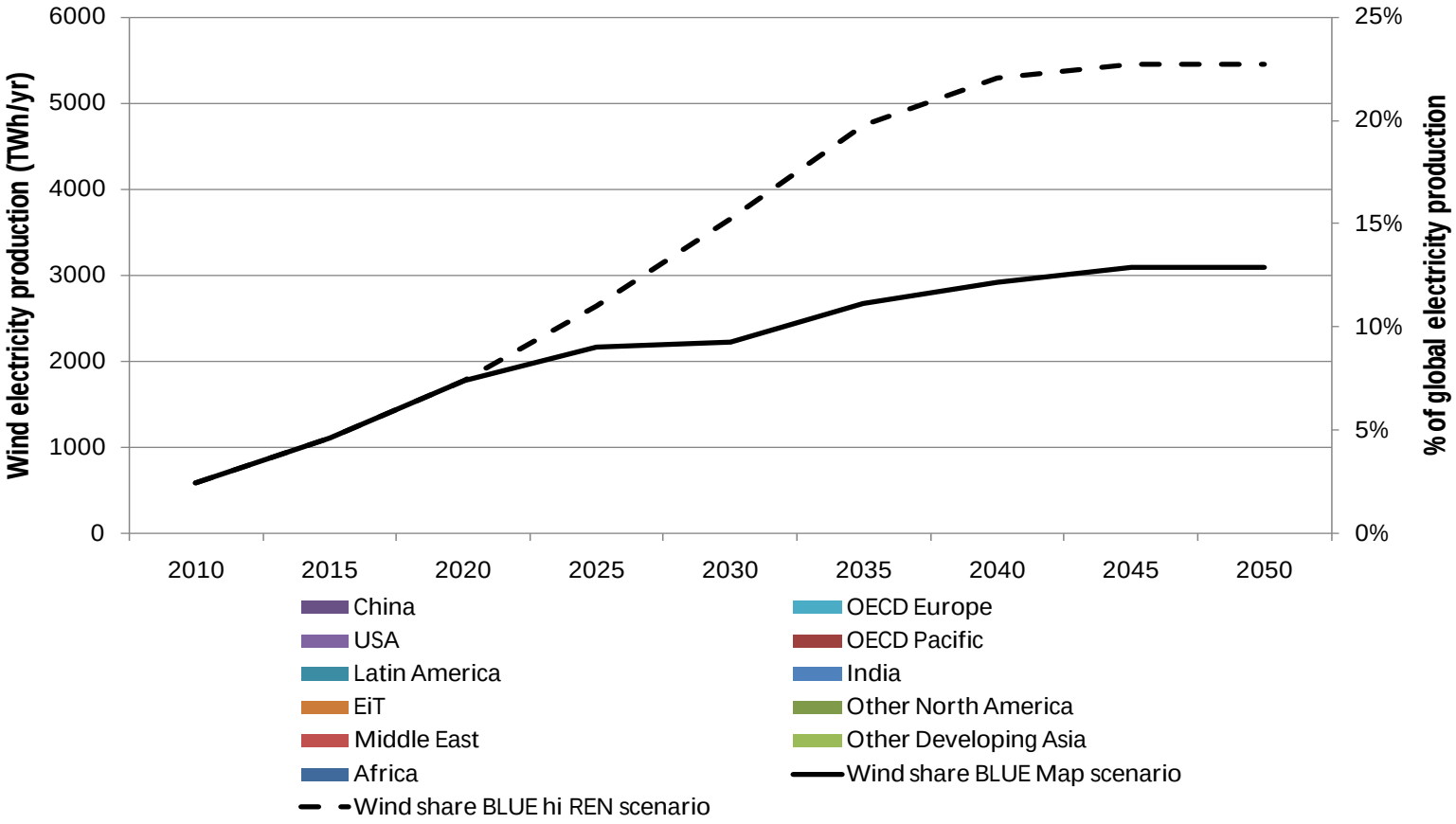
- **Consistent assessment of costs and benefits linked to the technology deployment**
- **Taking into account energy system aspects:**
  - **Interdependencies of a technology within the energy system**
  - **Competition with alternative technology options**
- **Identifying critical factors for technology deployment**
  - **Assessing effects of technology and policy choices on national energy situation**
  - **Uncertain future factors (e.g. energy prices, demand, technology success)**
- **Facilitating the discussions among experts and stakeholders in the roadmap process**

Tailoring the roadmap process

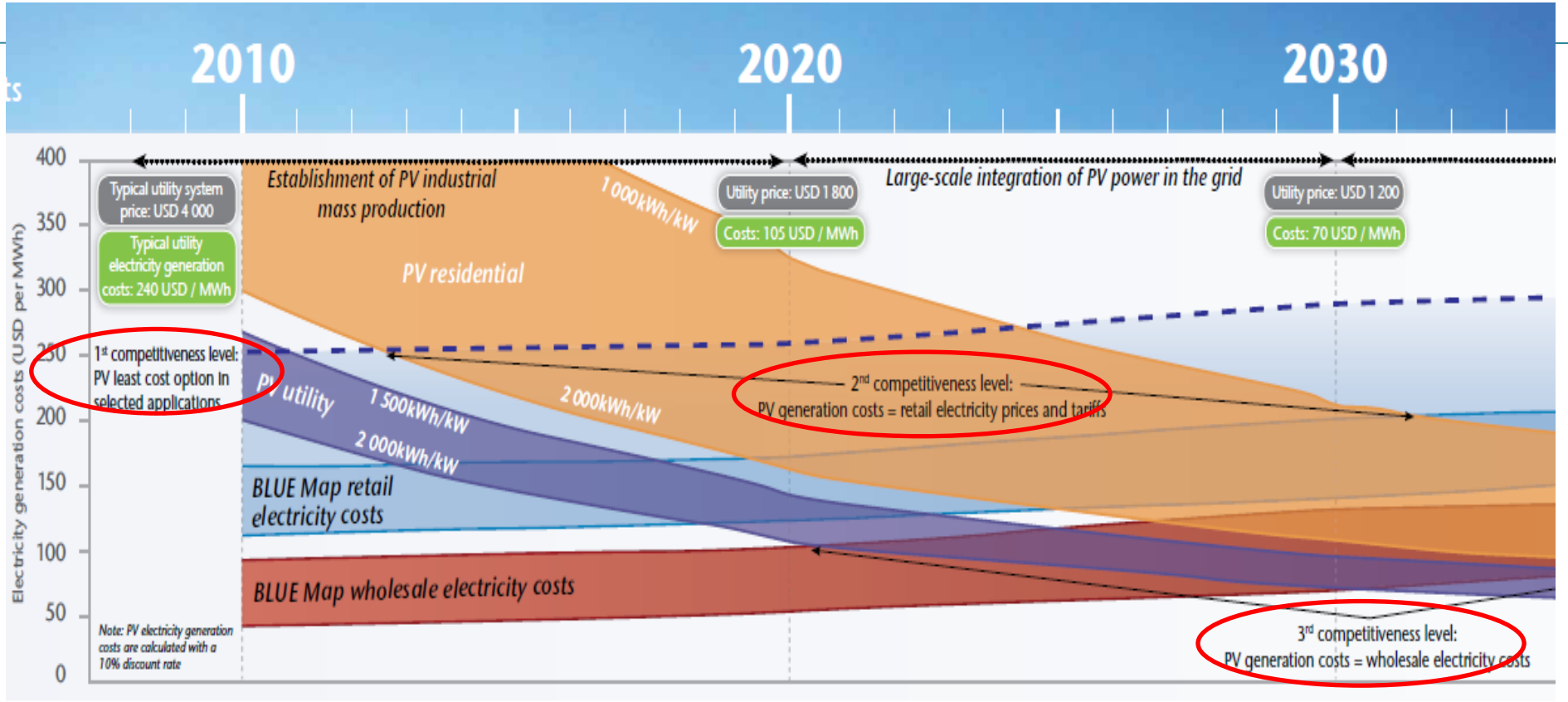
- Six considerations when designing a roadmap process:
  - Stakeholder participation
  - Resource constraints
  - Critical inputs
  - Roadmap design
  - Buy-in and dissemination
  - Monitoring and tracking

IEA ROADMAP EXAMPLES

Wind Roadmap: An ambitious growth pathway

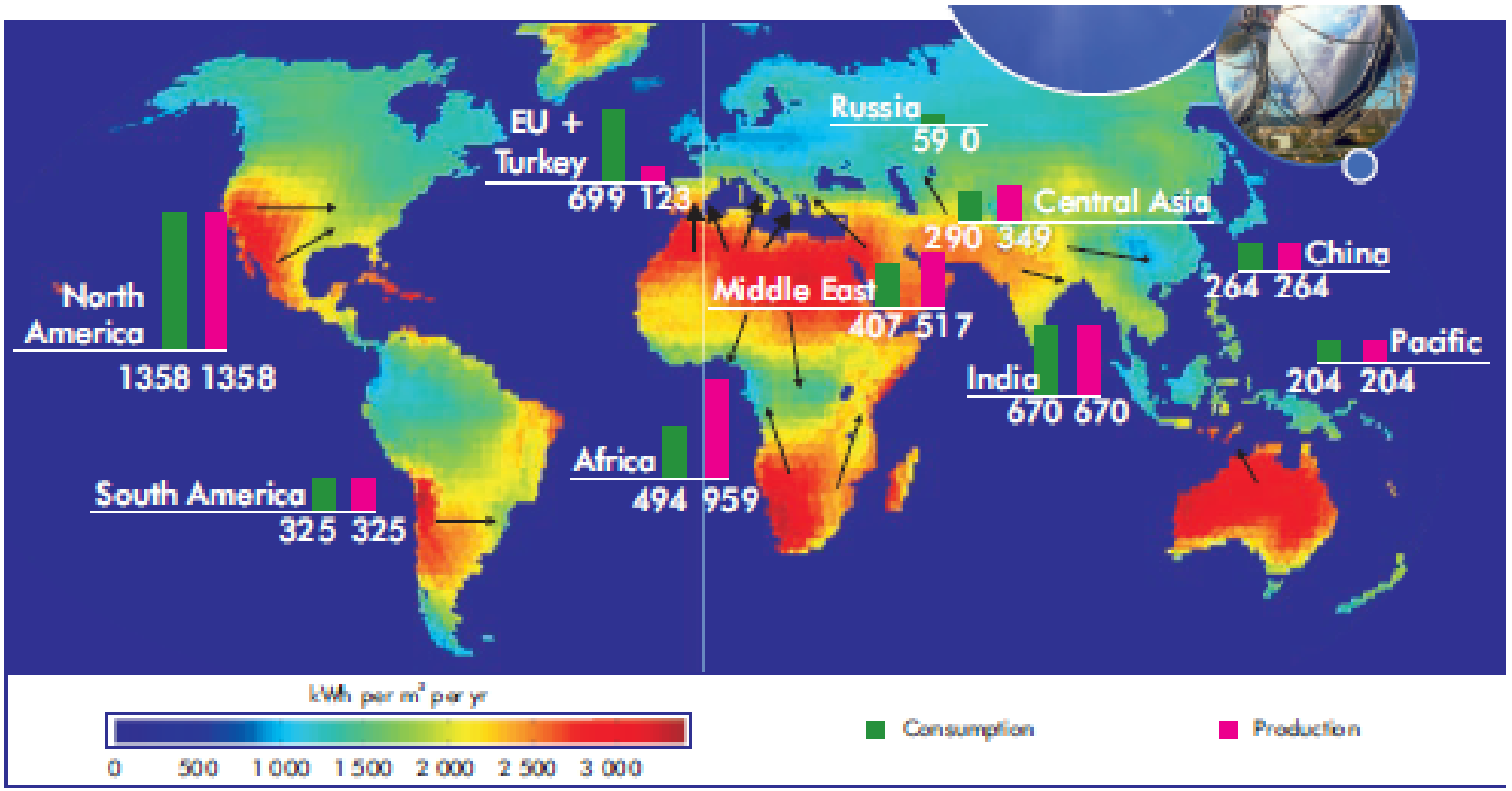


PV Roadmap



PV can provide 5% of global electricity generation in 2030, 11% in 2050

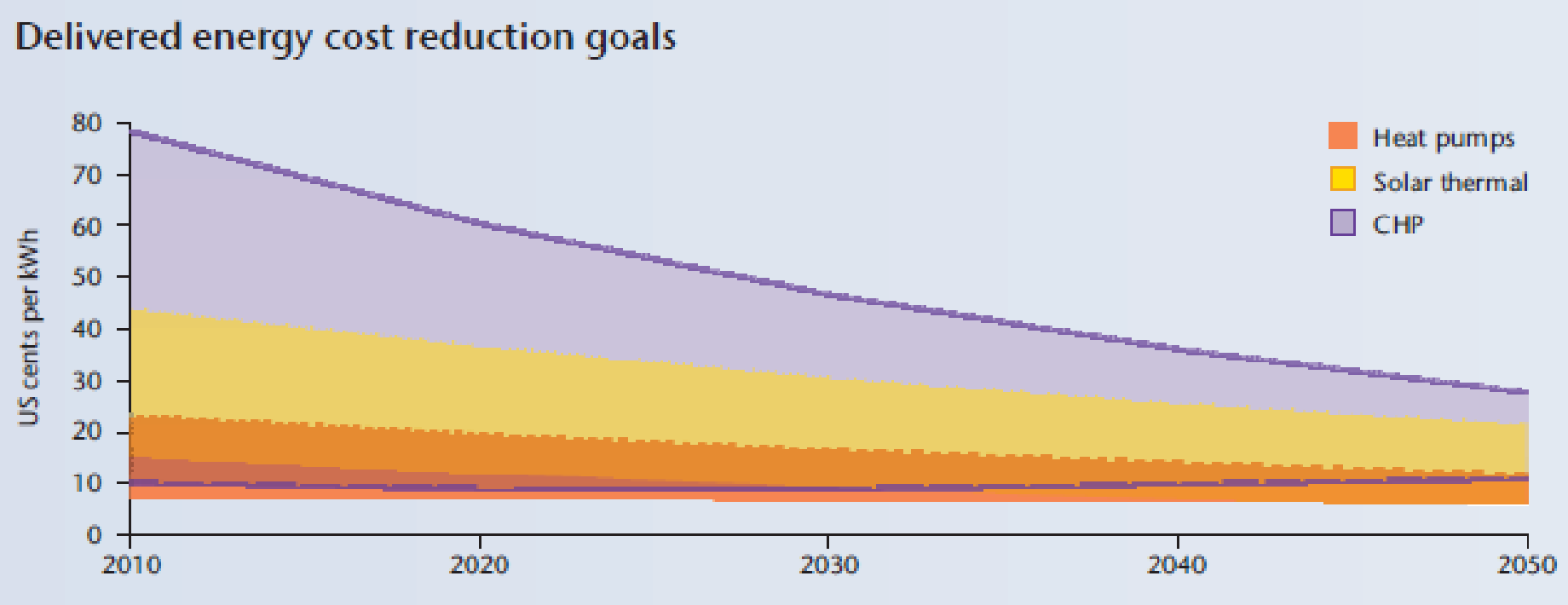
CSP Roadmap



Repartition of the direct normal irradiance (DNI) in kWh/m²/y, and of the production and consumption of CSP electricity (in TWh) by world region in 2050 as foreseen in this roadmap. Arrows represent transfers of CSP electricity from sunniest regions or countries to large electricity demand centres.

2050: A detailed regional assessment – with some HVDC lines

EE in buildings roadmap example:
Cost reduction goals



EV/PHEV roadmap example: milestones

Milestones:	2010-2012	2012-2015	2015-2020
Policy framework	Develop policy frameworks focused on early adopters with incentives for consumers / manufacturers		Review of policies and updates to reflect best practices; support for expansion of infrastructure and to ensure EV/PHEV sales are on track
Vehicles / batteries	Begin production of EV and PHEV models, low-production volume demonstrations to test batteries and controls, and assist design optimizations		Rapidly increase numbers of models offered and average production volumes; battery and other costs begin to decline
Codes / standards	Create common standards for plugs and recharging protocols in each major region		Ensure that smart metering is available for home recharging with dual tariffs in early adopter areas
Recharging / electricity infrastructure	Focus on areas likely to require recharging infrastructure through 2015; target early adopter homes and public locations		Begin major investments in increased street/office daytime commercial recharging, including rapid charging where possible
RD&D	Ensure early vehicle/battery models are safe; achieve near-term technical targets; continue RD&D on advanced battery designs		Progress toward battery cost targets of USD 300/ kWh; incorporate lessons learned from early experiences

NATIONAL ROADMAPS

China wind roadmap

- 1000 GW of wind,
17% of electricity production in 2050
- Cumulative investment of USD 600 bn by 2030 and USD 1.9 tn by 2050
- CO_2 savings of 1.5 Gt and reduction of 660 m tce
- Two possible pathways developed for transmission

Cement in India Roadmap

India Cement Technology Roadmap partners

wbcsd

iea

In consultation with

CII

NCB

Principal supporter

IFC International Finance Corporation World Bank Group

Industry supporters

Shree Cement

ADITYA BIRLA UltraTech

Ambuja Cement

HEIDELBERGCEMENT

ACC ACC Limited

LAFARGE INDIA

Zuari Cement Italcementi Group

CIMPOR

MAHA CEMENT

Roadmap development process

Phase I

Technology papers (CII/NCBM)

Cement demand data, data modeling and analysis (IEA)

Data coverage (>70% of Indian industry)

Partner and stakeholder review

Stakeholder outreach

- Technology
- Financing
- Policy

Phase II

unit-level analysis at 6-9 CSI member company cement plants

A final thought

- Roadmaps can be powerful tools for
  - Aligning interests and skills of diverse stakeholders
  - Identifying steps and timing needed to achieve a chosen future
  - Generating buy-in and support that leads to real action
  - Monitoring progress against stated milestones and adjusting the plan as needed

For more information

- Download the guide:

  http://www.iea.org/papers/roadmaps/guide.pdf

- Contact:

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