The Future Grid: Electric Highways

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THE FUTURE GRID: ELECTRIC HIGHWAYS
Role of VRE in the Future Grid

- Germany
- United Kingdom
- Australia
- Spain
- United States
- Mexico
- Italy
- France
- Saudi Arabia
- Japan
- WORLD
- China
- India
- Turkey
- Argentina
- Korea
- Canada
- Indonesia
- Brazil
- South Africa
- Russia

- VRE share in annual generation (2014)
- Additional VRE share in annual generation (2014-2020)
- Additional VRE share in annual generation (2020-2030)

Countries and their respective VRE contributions are shown with different colors for different time periods.
How IRENA Supports the Future Grid
Developing a long-term strategy
- Roadmap on renewable energy grid integration
- Technology roadmap on electricity storage

Facilitating the implementation process
- Regulatory Trainings
- Grid codes development for VRE integration

Supporting operation and management
- Grid stability assessments methodology
- Grid stability assessments for SIDS

Policy & regulation
- Addressing Variable Renewables in Long-term Energy planning (AVRIL)
- Power pool models for energy planning

Market design
- Role of Baseload Power
- Grid investments for renewables
- Practitioner’s guide for VRE grid integration
- Minigrid project navigator

Infrastructure design
- Smart grids and renewables cost benefit analysis
- Electricity storage technology brief
- Minigrid innovative technology outlook
- Battery storage technology outlook

Technology components
- Smart grids and renewable guide
- Off-grid renewable energy systems
- RE grid integration technology brief
- Grid stability assessments methodology
- Grid stability assessments for SIDS

Guidelines
- Market design
- Technology roadmap on electricity storage
- Roadmap on renewable energy grid integration

Methods
- Model application
- Technical information

Model building
- Capacity building

IRENA SUPPORTS THE FUTURE GRID
**TAILORED TO STAKEHOLDERS**

**DIMENSIONS**
- Technical
- Economic
- Political

**TOOLKIT**
- Technology briefs and outlooks
- Grid integration studies
- Grid connection codes
- Dynamic modeling
- Long term energy planning with VRE
- Cost-benefit analysis
- Market assessment
- VRE grid integration & storage roadmaps
- Knowledge framework
- Regulatory empowerment

**TAILOR-MADE APPLICATIONS**
- Clean Energy Corridors – Africa, ASEAN, Central America
- Grid Integration Studies – SIDS
- Long-Term Planning – Africa Power Pools
- National & Regional Regulatory Training
Moving towards systems with more VRE requires improvements in existing long-term planning models.

Identify best practices for long-term planning will address “how to” account for:
- Firm capacity
- Flexibility
- Stability
- Grid investments

In an iterative process Grid Studies from IRENA include:
- Assessment of security and reliability of operation with VRE
- Identification and assessment of operation and expansion mitigation measures
- Estimation of RE generation shares
EXAMPLE: Evaluating the system value of energy storage in South Africa

METHODOLOGY

STEP 1
• Determine regionally appropriate applications considering both supply and demand

STEP 2
• Identify alternatives to each of the services that storage can provide

STEP 3
• Independently assess the system value of storage applications versus alternatives

STEP 4
• Reconvene results and prioritise applications with greatest benefits

BENEFITS
• Address peak demand deficit: 5000 MW
• Reduce load curtailment: currently 10% of industrial electricity demand
• Load shedding reduction: 14-140 R/kWh
• Peak and off-peak rates: 64 – 28 Rc/kWh
• Transmission line deferral: 284k R/km
• Reduced electricity losses: 0.2 – 1.2 R/kWh
# Examples of Best Practices

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