Some policy questions related to the ongoing renewable energy transition

- How can RE help to meet policy targets – energy security, environment, economic targets?
- What is the optimal RE target?
- How much VRE can our power system accommodate? Will the lights stay on?
- How to limit the cost of an RE transition, is RE affordable?
- How much biomass is available and can be deployed sustainably?
- What level of investment is needed and how can this be financed?
- What is the best policy instrument choice?
- What can we expect from innovation and technological change?
Breakdown of Global Renewable Energy Use in 2010

Globally 18% RE in Total Final Energy Consumption (TFEC)
Half is traditional biomass, 8.4% modern renewables

Source: IRENA (2014); SE4ALL Global Tracking Framework (2013)
Renewables Dominate New Power Sector Capacity Additions

23% RE power generation in 2013

Non-renewables
(Coal, Gas, Nuclear and Oil)

Renewables

- Hydro: 16%
- Biomass: 2.5%
- Wind: 2.5%
- Solar: 1%
- Geothermal: 0.4%

Share of global capacity additions

Global Investment in Renewable Energy Capacity additions rise, unit cost fall
Significant cost differences persist
An opportunity to accelerate deployment

![Graph showing LCOE (USD 2014/kWh) for various energy sources over the years 2010 and 2014.](Source: IRENA (2015))

- Biomass
- Geothermal
- Hydro
- Solar PV
- CSP
- Wind
  - Offshore
  - Onshore

Most expensive projects
 Significant reduction average project cost

Fossil fuel power cost range

Wide cost range

Left side: 2010
Right side: 2014

Source: IRENA (2015)
Drivers for Renewable Energy Vary
Renewables Outlook

• Doubling the RE share from 18% in 2010 to 36% in 2030 is technically achievable with existing technologies
  ▪ Higher shares in power generation
  ▪ More attention needed for heating and transportation fuels
  ▪ Efficiency, access and RE policies need to be coordinated

• Doubling is affordable when externalities are accounted for
  ▪ However these are not reflected in today’s prices and markets are distorted because of energy subsidies
  ▪ Macro-economic benefits include more jobs; economic activity; health benefits; a cleaner environment; a higher level of energy security

• Biomass is key resource

• Potential exists in all countries, and differentiated action
26 countries – 75% of global energy consumption – Realistic potential to scale-up renewables

China is the largest single market for global renewable energy use
Country RE Potentials, 2030

Values above bars show the growth in RE share between 2010 and REmap 2030

- **2030 Reference Case**
- **REmap 2030**
- **2010**
Scenario Studies for 2030 Synergies between Energy Efficiency and Renewable Energy Share

Global RE Use in 2030 including REmap Options

Remap 2030 – 132 EJ (final energy) 60% is biomass
Opportunities in power generation growth potential is under-estimated

- Renewable energy share in power generation increases to 44%
- Variable renewable energy share in total generation 17% (solar PV & wind)
Technology Cost Curves

REmap Options Cost-supply Curve in 2030

- US & China together fight climate change based on new GHG emission targets
- Cooperation can cut GHG emissions by 13% compared to BaU in 2030
Cost and Benefits

Externalities are not well understood
Energy Supply Consequences
RE can be the largest Energy Source by 2030

- The doubling of renewables will mostly offset coal consumption
- Fossil fuel substitution yields 8.6 Gt CO₂ reduction – on par with the role of efficiency
• Between now and 2030, **USD 650 bln/yr** investment needs in RE technologies
• By 2030, biomass feedstock market of **USD 550-1,500 bln/yr**
Potential for variable RE, 2030

- Germany
- United Kingdom
- Australia
- United States
- Mexico
- Italy
- France
- South Arabia
- Japan
- WORLD
- China
- India
- Turkey
- Argentina

VRE share (2014) • additional VRE share (2012-2030)
AVRIL rationale

• Viability of long-term RE targets
  ▪ Challenged by system operators and policy makers on the ground of system reliability

• Interlinkages with grid planning

• Policy makers, system operators, and energy modellers do not communicate enough
AVRIL objectives

In the context of developing countries;

• Assess how properties of VRE are relevant for long term policy making
• Identify pillars of a robust long-term planning methodology
• Bridge inter-stakeholder knowledge gaps

→ Enhance the IRENA’s energy planning advisory service
With higher VRE share, the coordination among different planning stages become increasingly important.

- Long-term energy planning models (time resolution: seasons – years)
- Geo-spatial planning models (time resolution: static)
- Production cost models (time resolution: minutes – hours)
- Load flow analysis (time resolution: static)
- Stability analysis (time resolution: millisecond to minutes)

Steady state grid currents and voltages
Highly-resolved dispatch and operational details
Network topology
Identification of RE zones and transmission projects
Generation and network capacities
Feedback

High detail
Wide scope

→ IRENA Lunch time seminar on Day 2
Electricity Access

- What is electricity access? A light, a TV, an A/C, an EV?
- How much grid expansion, how much minigrid/offgrid
- Are minigrids a transition stage towards centralized grids or can they be a substitute
- Business cases – perfect foresight/rational decision making/economies of scale
  - Blackouts don’t exist in such a world
Opportunities for renewables in off-grid systems – how to model niches

Some 1.16 billion people without electricity access today

26 million households served through off-grid systems

50 – 250 GW potential to hybridise existing diesel generator capacity, 12 GW on islands

1 million telecom towers in South Asia and Sub-Saharan Africa

Source: World Bank
The technical solutions

Smart grid technologies
- Advanced control systems
- Distribution automation
- Smart / grid friendly inverters
- Smart advanced metering
- Data collection technologies
- Forecasting

Energy storage solutions
- Batteries
- Flow Batteries
- Flywheels
- Thermal storage
- Pumped hydro

Demand side options
- Demand response
- Electric vehicles
- Desalination
- Ice cooling systems

Source IRENA
Market Design

- Markets complement systems engineering
- Use ongoing data revolution for power system management
- Pricing reflecting cost
- Wholesale vs retail prices – very different decision environments
- Need for capacity markets – or not?
- Valuation of grid services (frequency and voltage control, etc)
- Perfect competition rarely reflects reality, how to model imperfections
- Also business models deserve more attention
Thank You!