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GLOBAL ENERGY TRANSITION

MODELLING CHALLENGES

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Abu Dhabi | June 3, 2015

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

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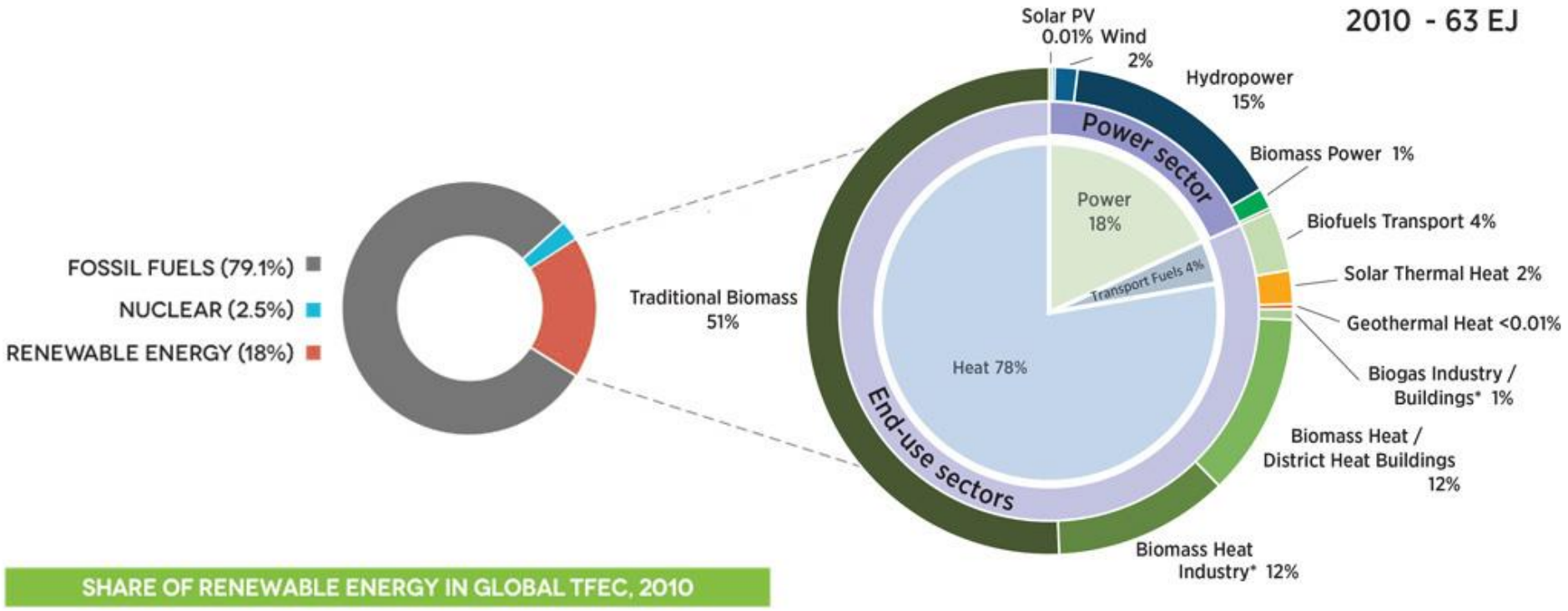
Globally 18% RE in Total Final Energy Consumption (TFEC)
Half is traditional biomass, 8.4% modern renewables



Source: IRENA (2014); SE4ALL Global Tracking Framework (2013)

Renewables Dominate
New Power Sector Capacity Additions

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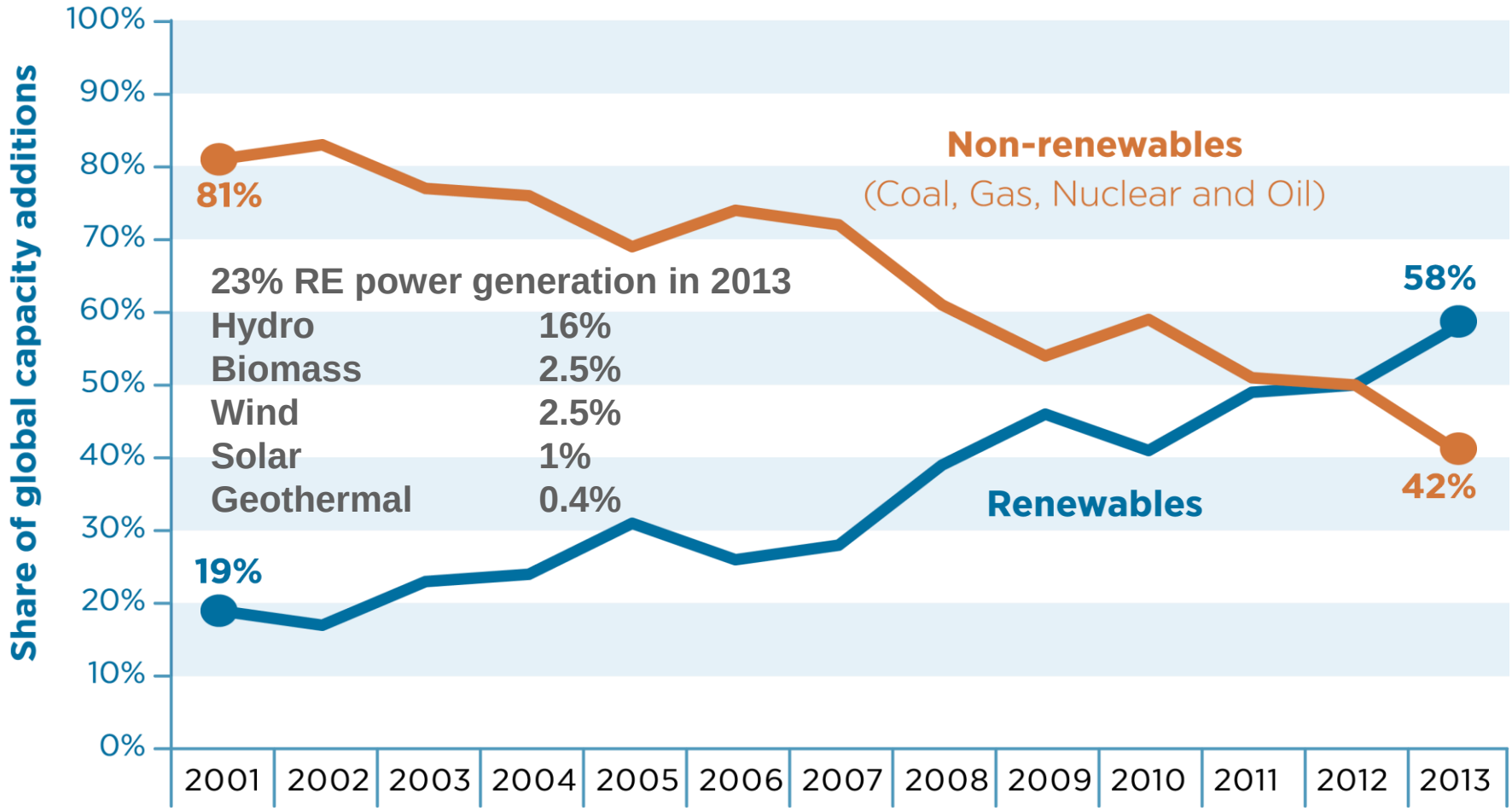

Global Investment in Renewable Energy Capacity additions rise, unit cost fall

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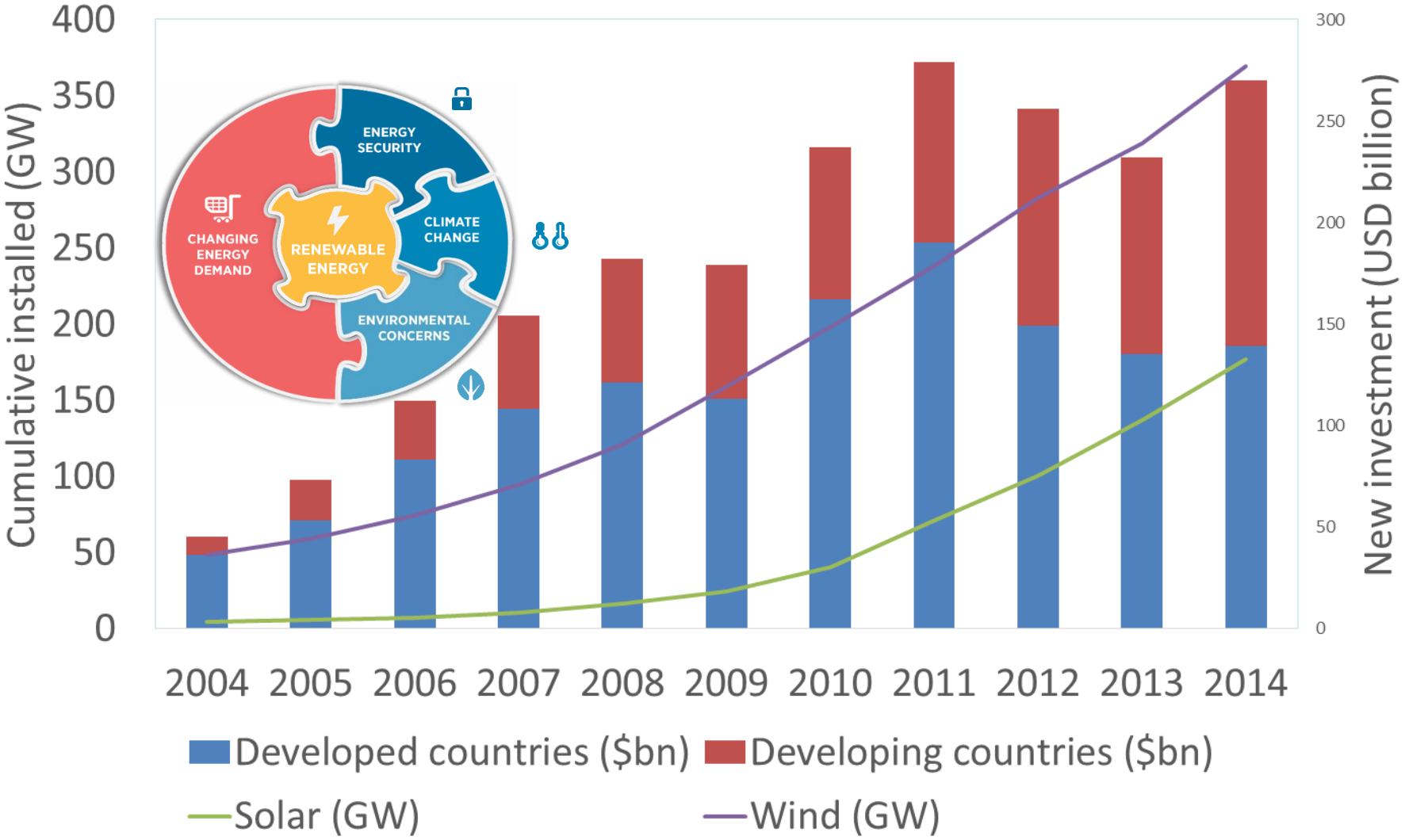
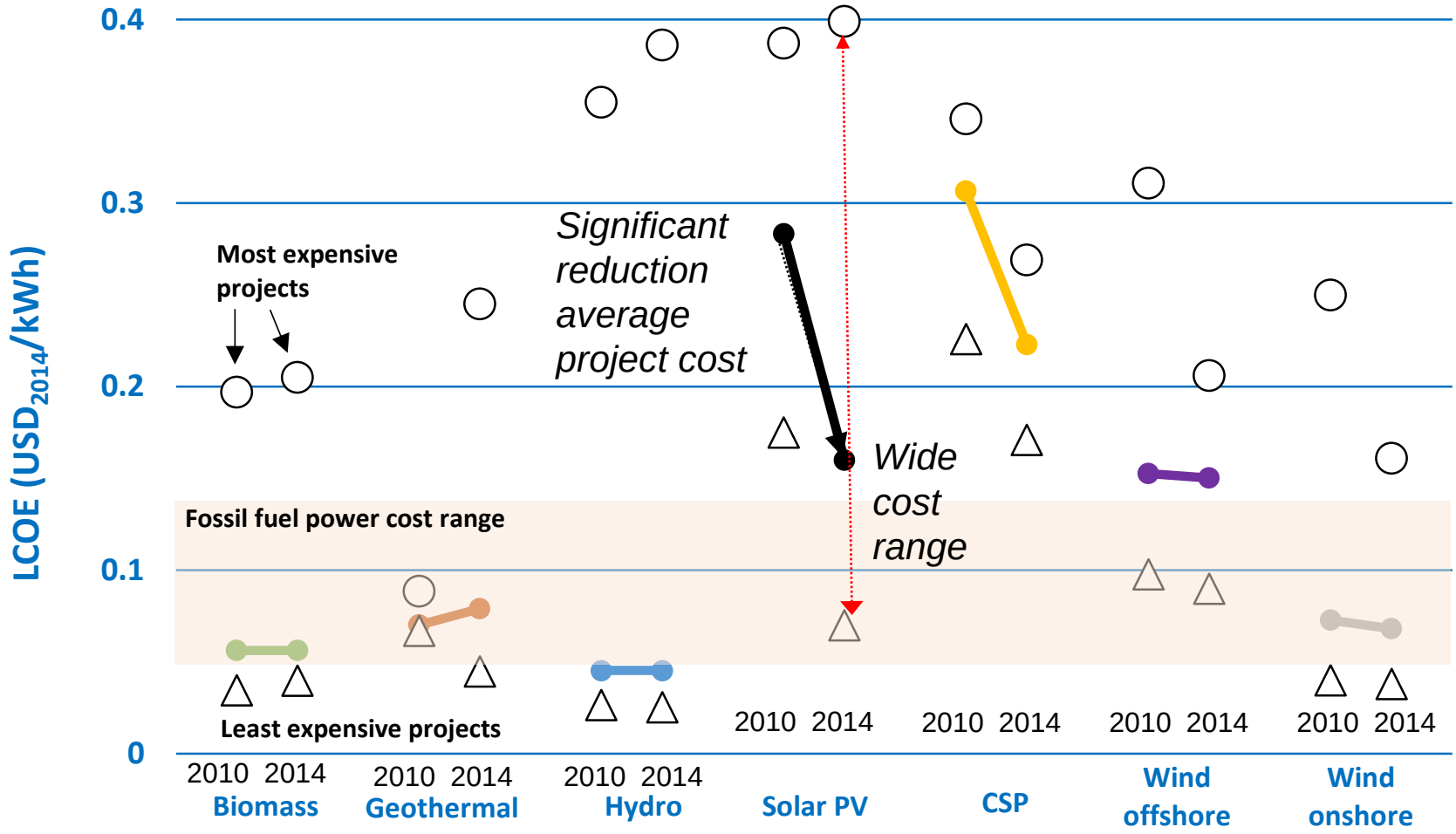


Significant cost differences persist

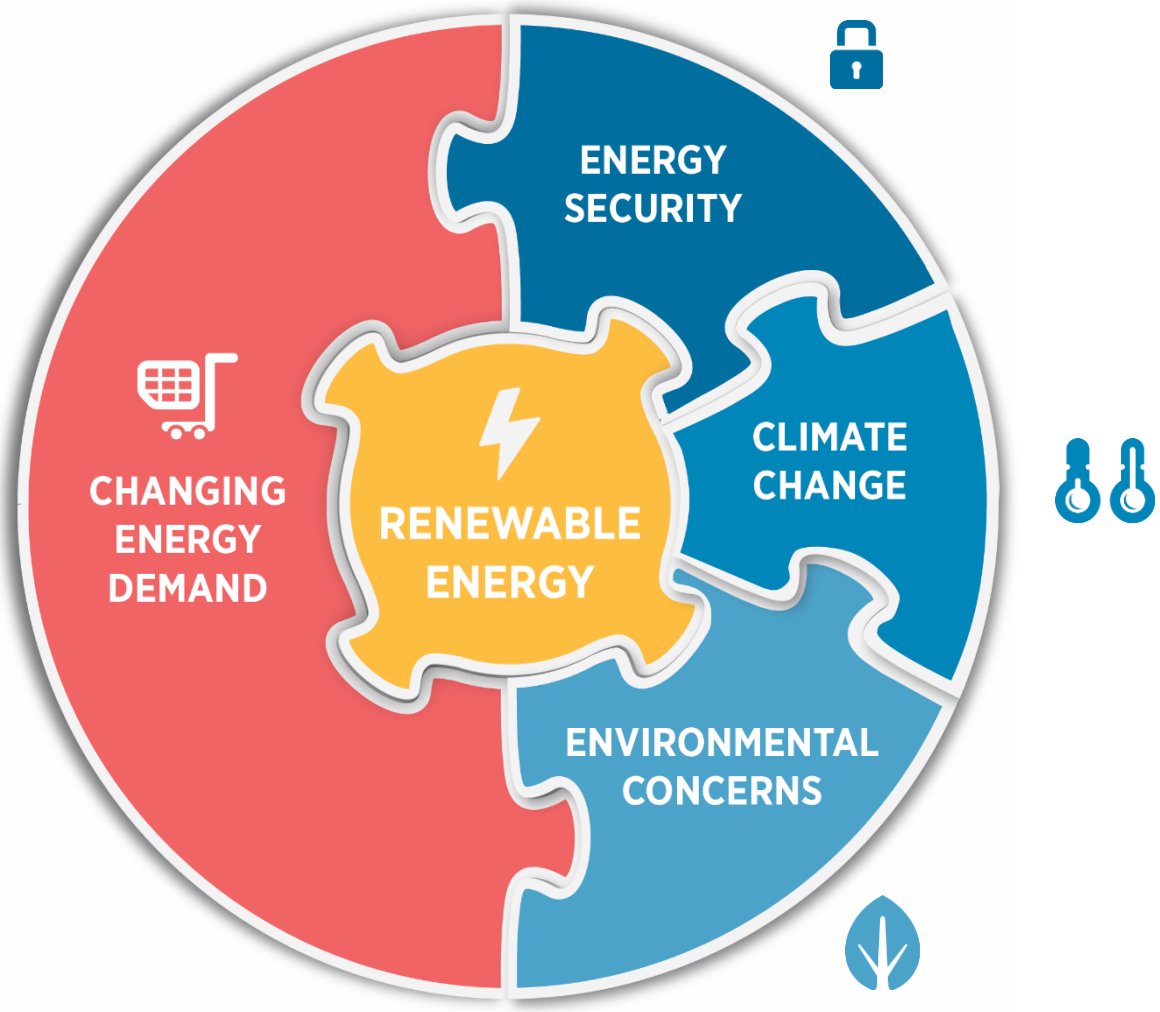
An opportunity to accelerate deployment



Left side: 2010
Right side: 2014

Source: IRENA (2015)

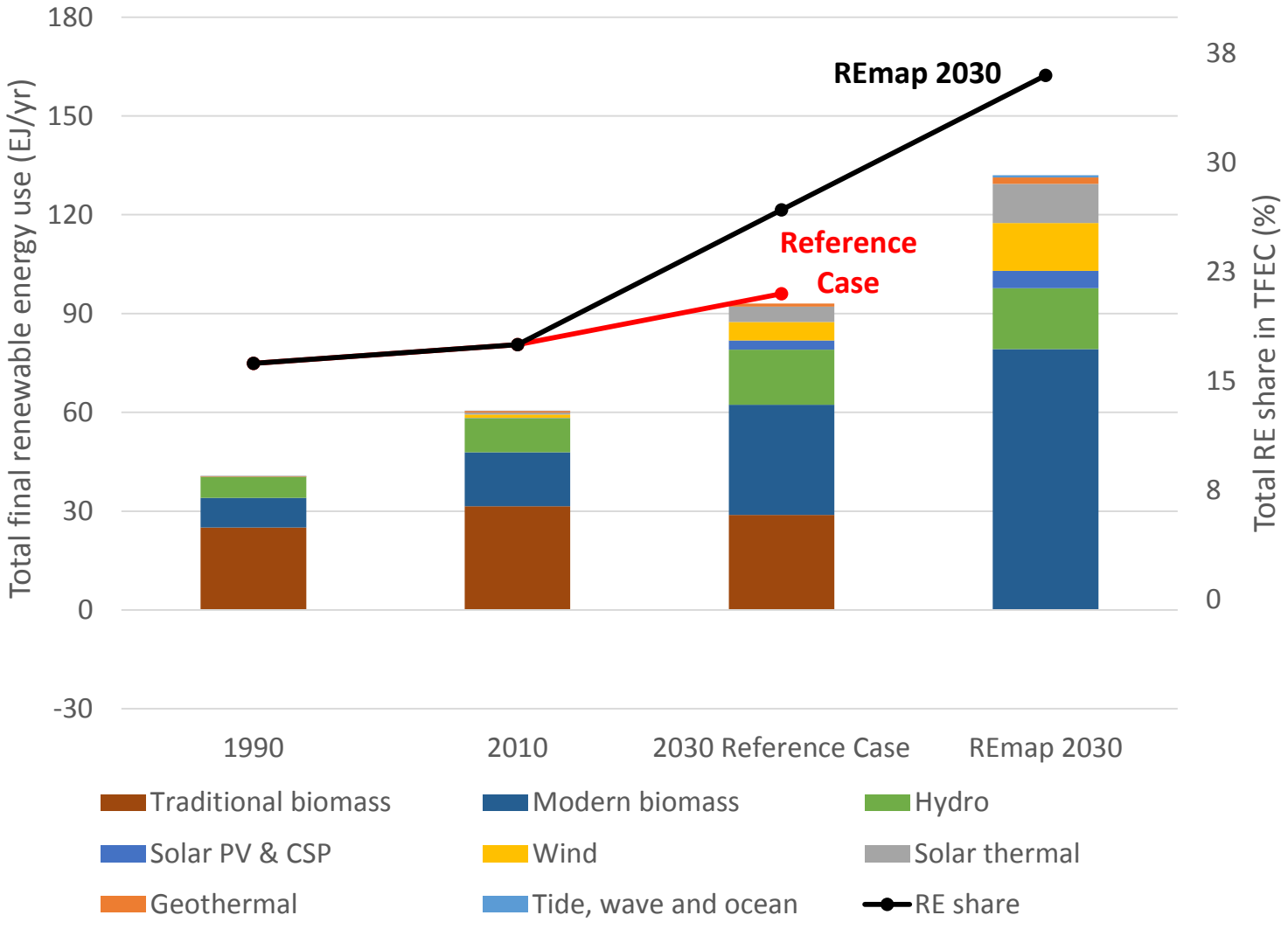
Drivers for Renewable Energy Vary



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 todays 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**

Global Renewable Energy Use Change



Mapping Out the Renewable Energy Transition

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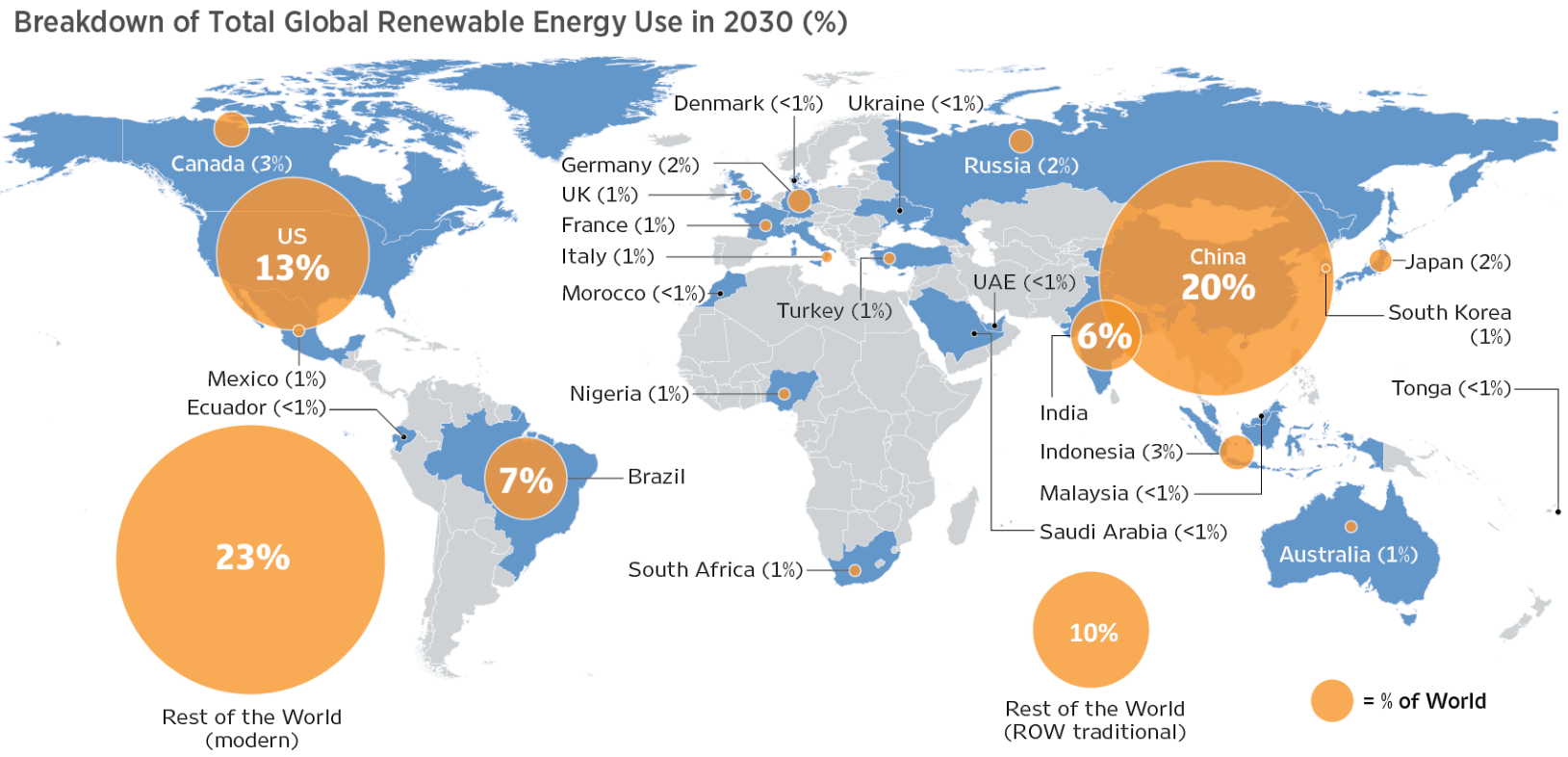
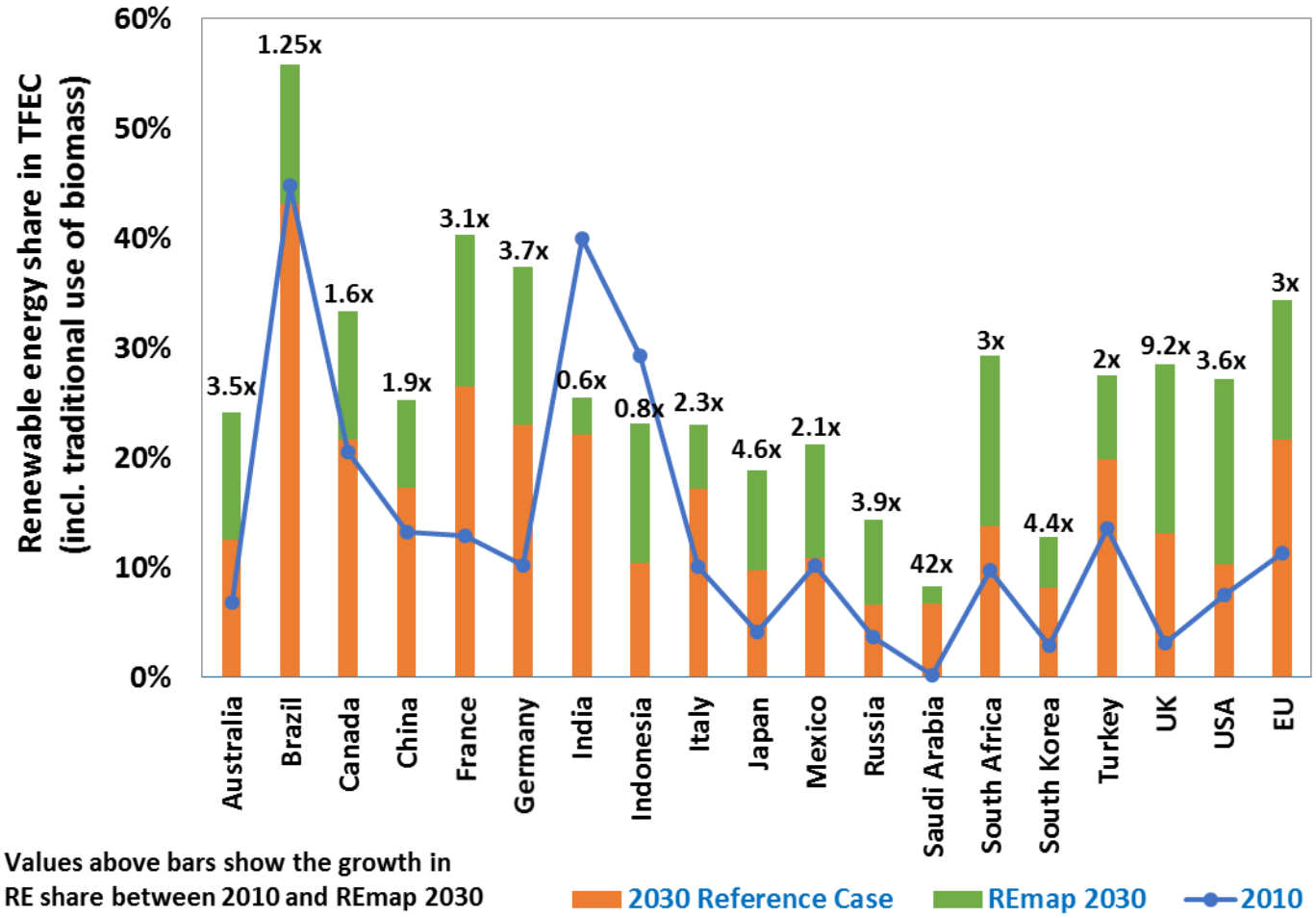


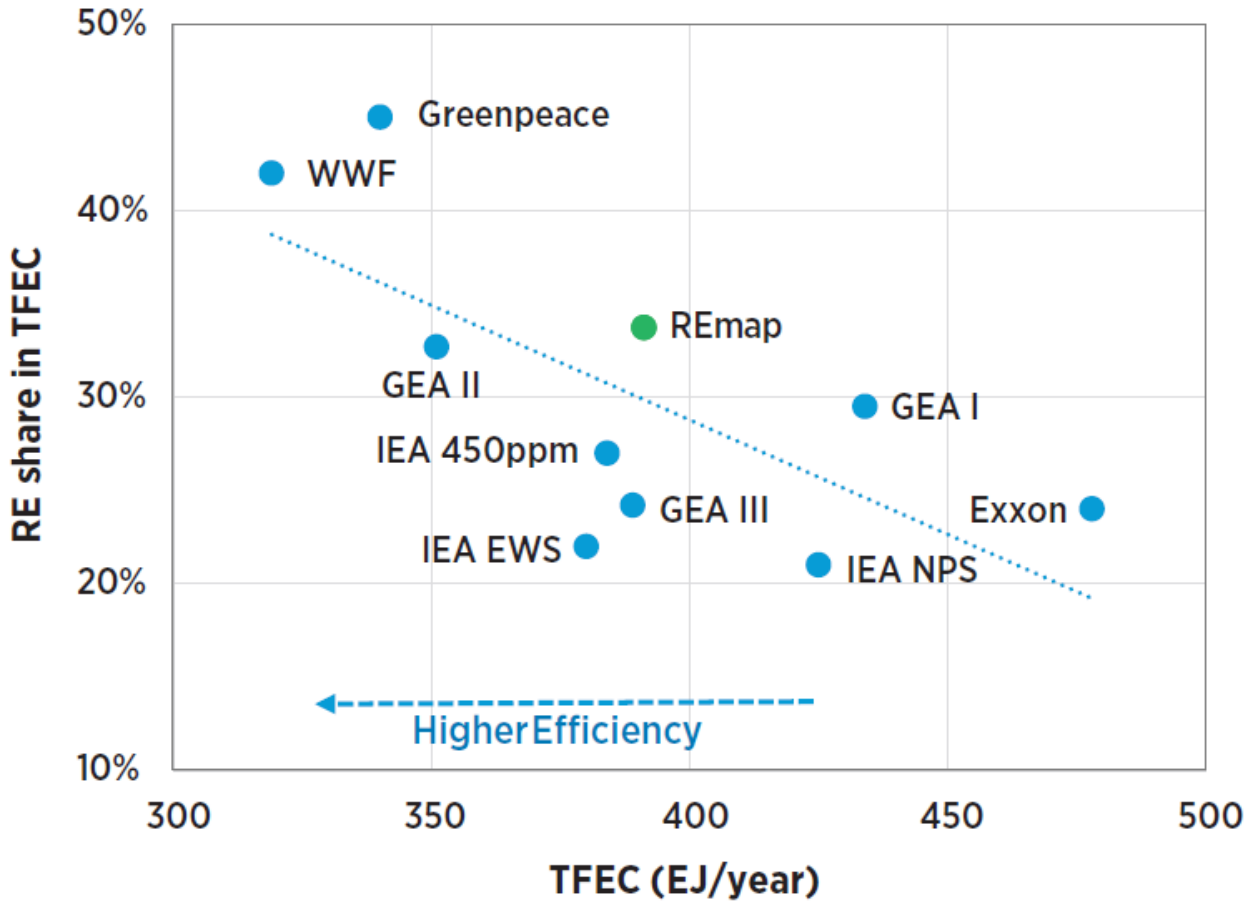
26 countries – 75% of global energy consumption – Realistic potential to scale-up renewables

China is the largest single market for global renewable energy use

Country RE Potentials, 2030



Scenario Studies for 2030 Synergies between Energy Efficiency and Renewable Energy Share



EWS: Efficient World Scenario; **GEA:** Global Energy Assessment; **NPS:** New Policies Scenario; **WWF:** World Wildlife Fund

Global RE Use in 2030 including REmap Options

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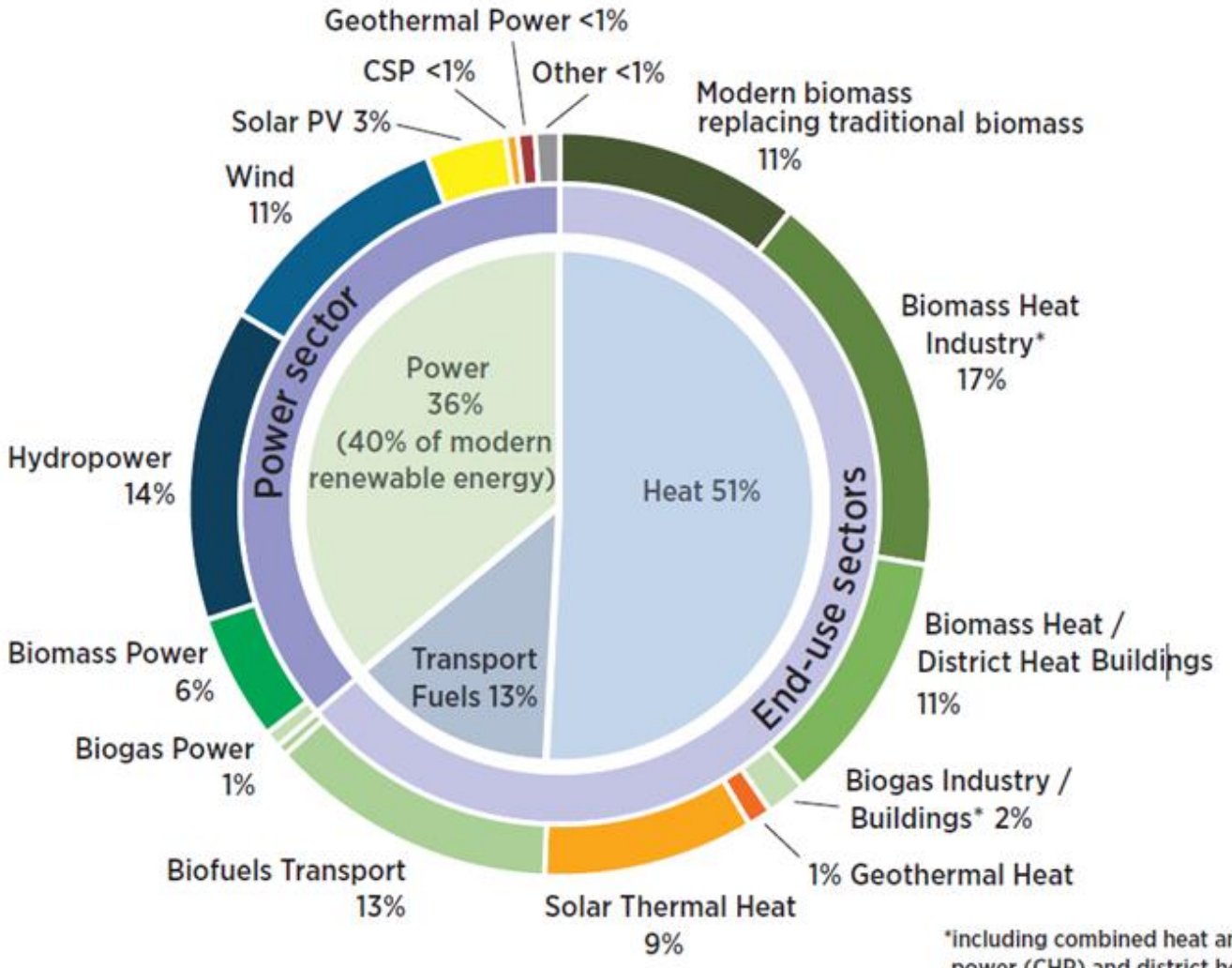
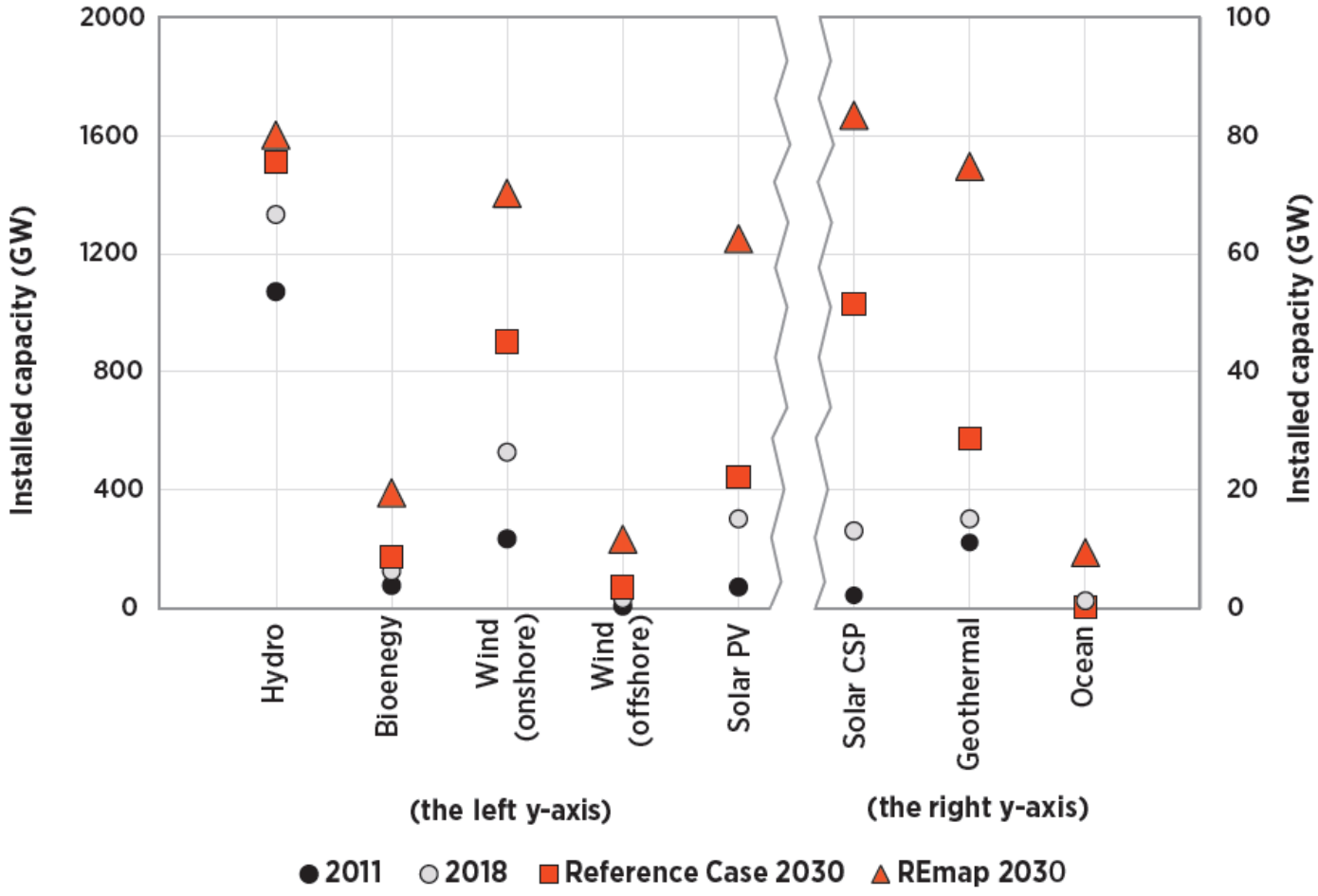
Remap 2030 – 132 EJ (final energy) 60% is biomass

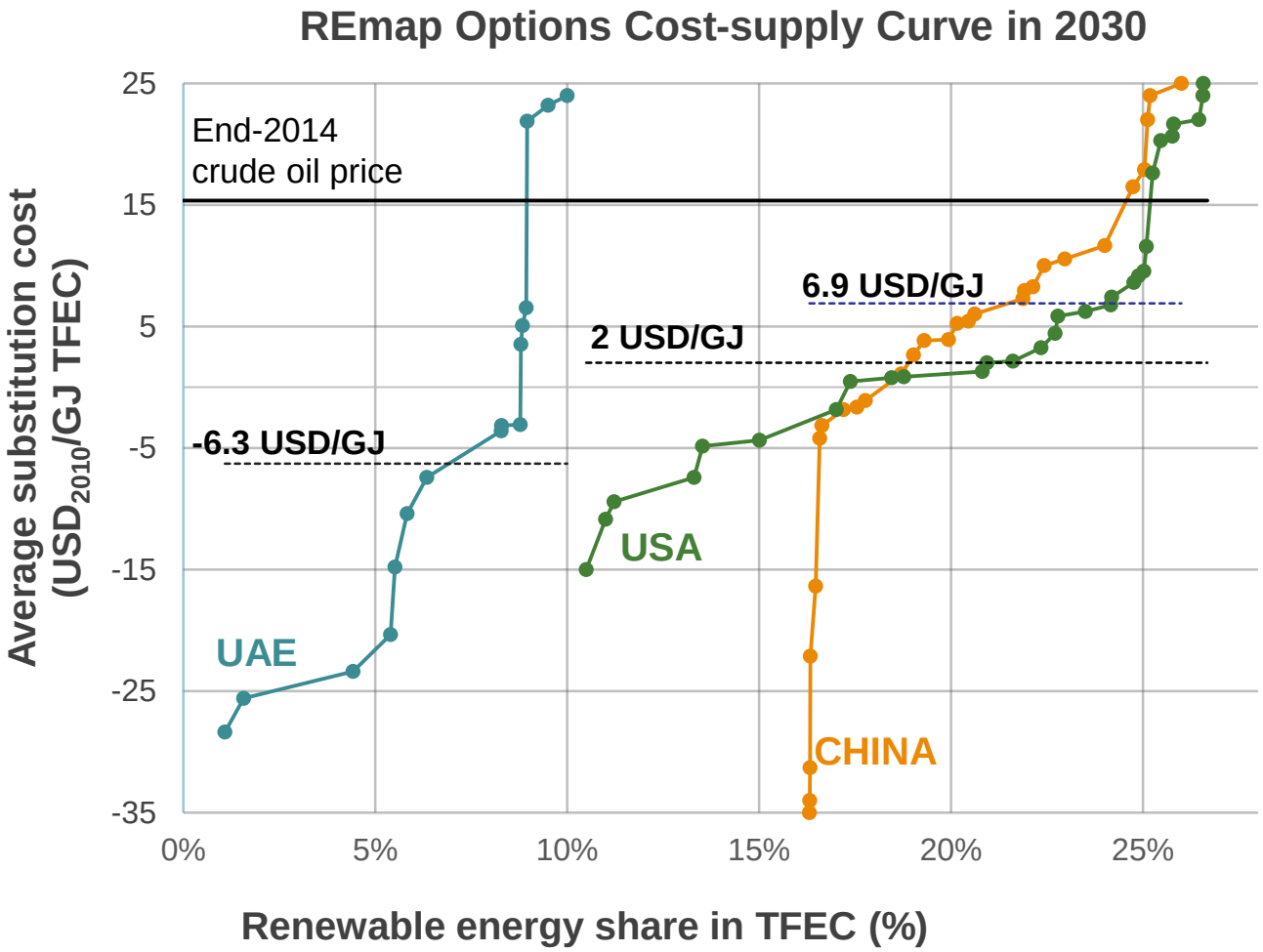


Opportunities in power generation growth potential is under-estimated



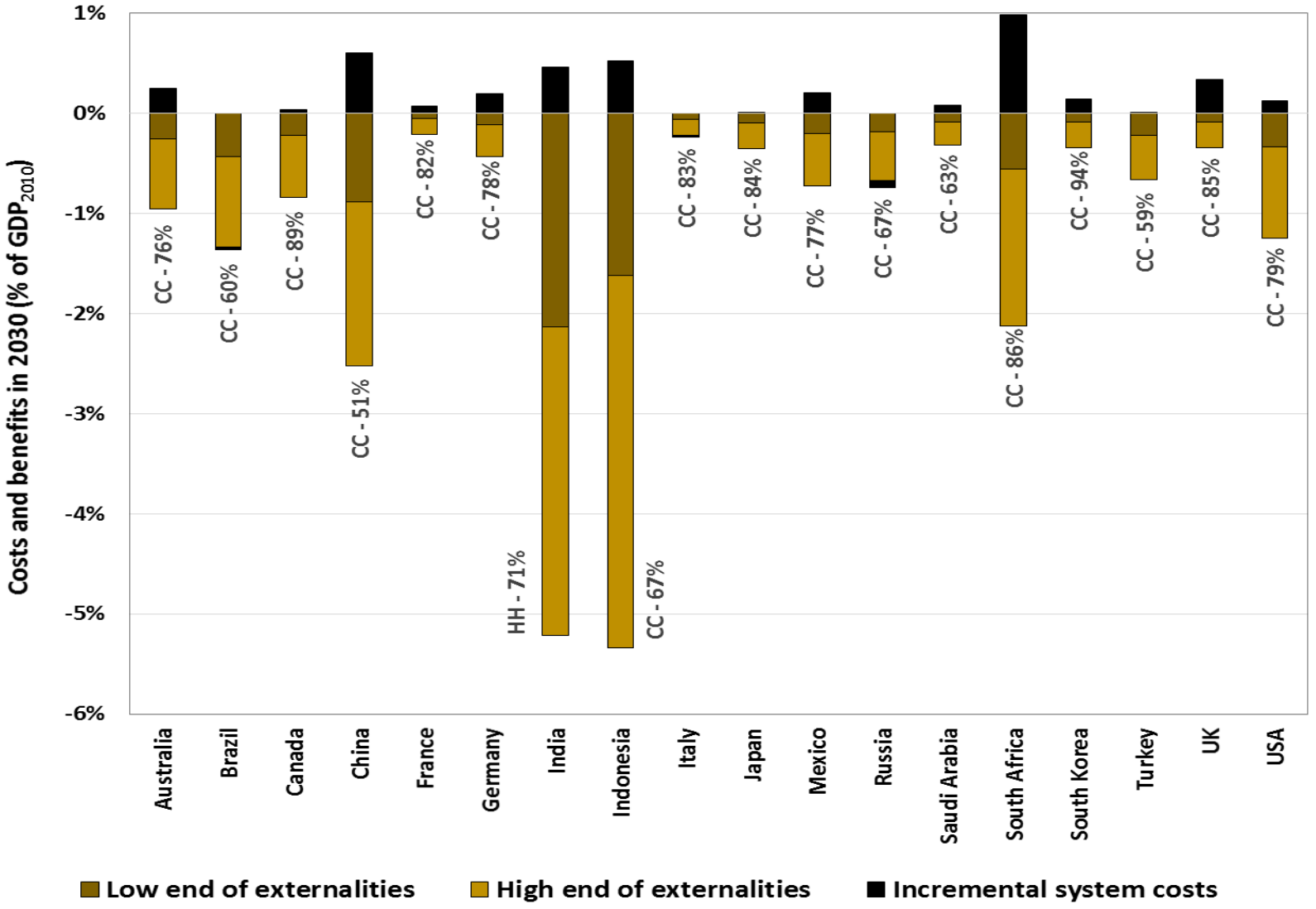
- Renewable energy share in power generation increases to 44%
- Variable renewable energy share in total generation 17% (solar PV & wind)

Technology Cost Curves

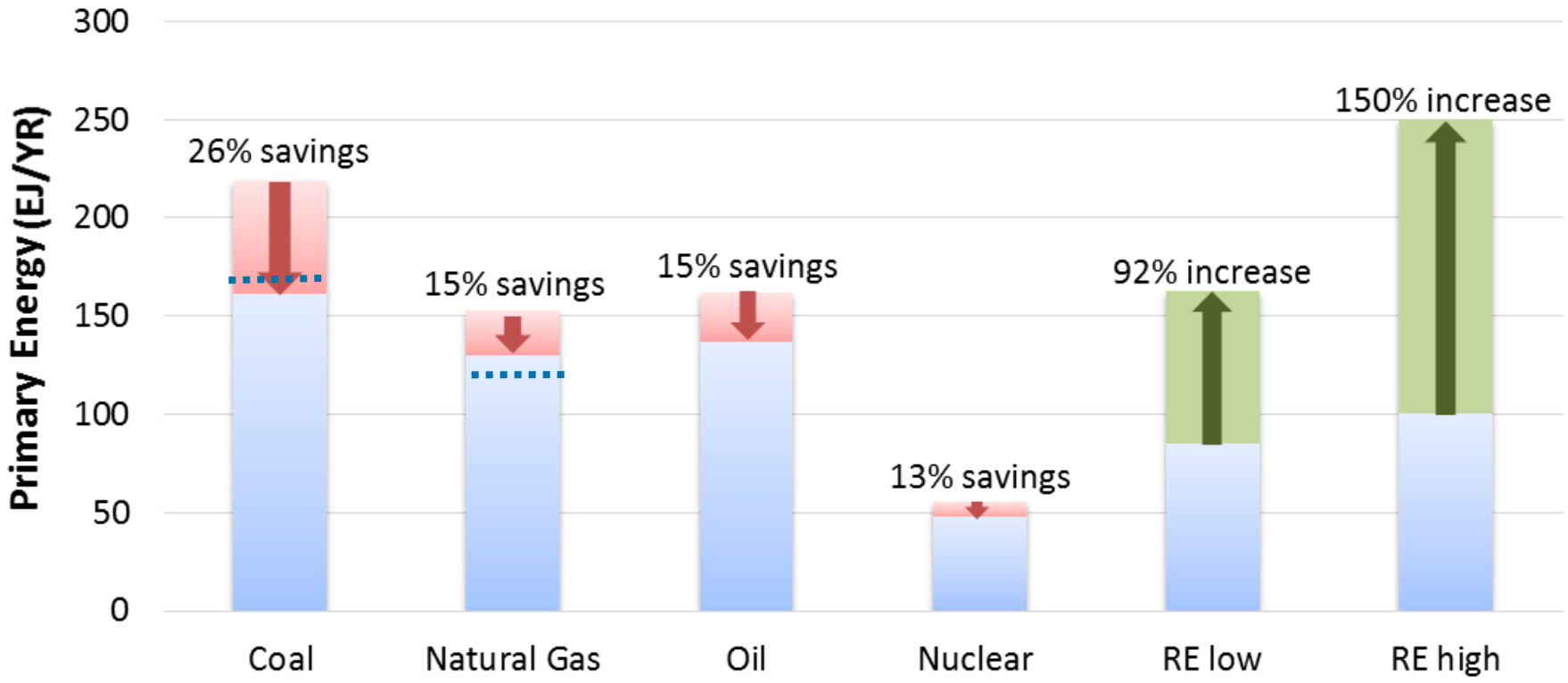


- US & China together fight climate change based on new GHG emission targets
- Cooperation can cut GHG emissions by 13% compared to BaU in 2030

Cost and Benefits
Externalities are not well understood

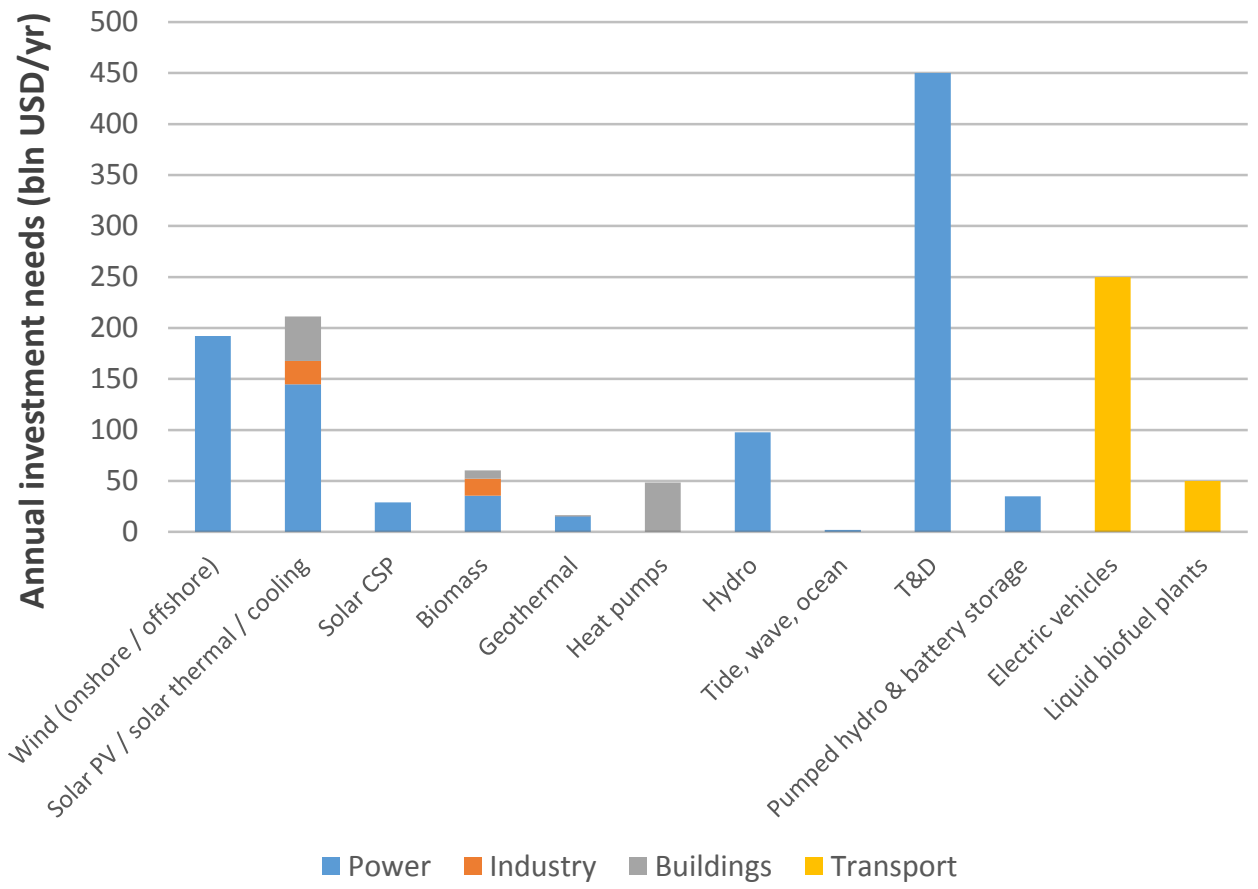


Energy Supply Consequences
RE can be the largest Energy Source by 2030



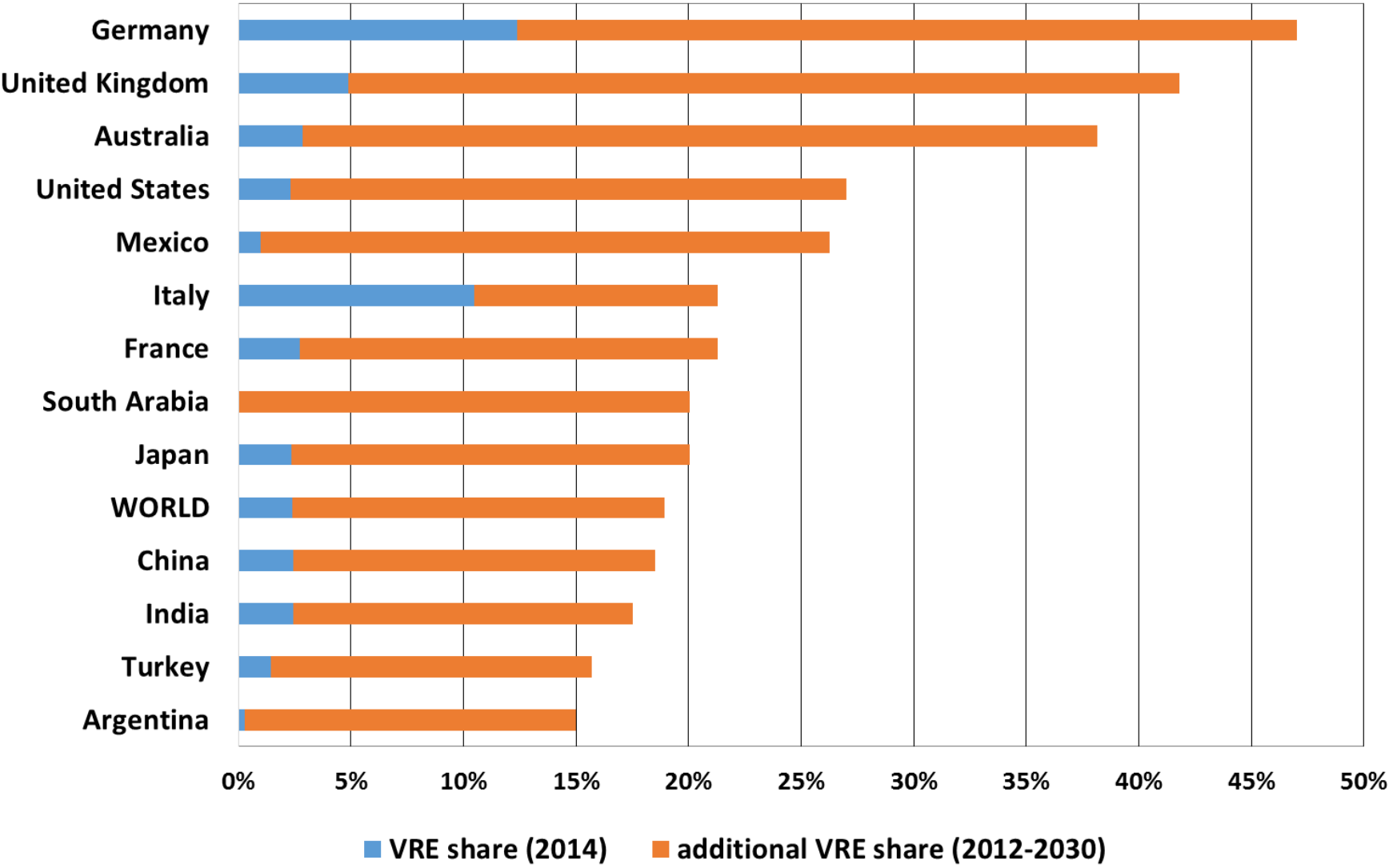
- The doubling of renewables will mostly offset coal consumption
- Fossil fuel substitution yields 8.6 Gt CO_2 reduction – on par with the role of efficiency

Market Opportunities between now and 2030



- 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



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

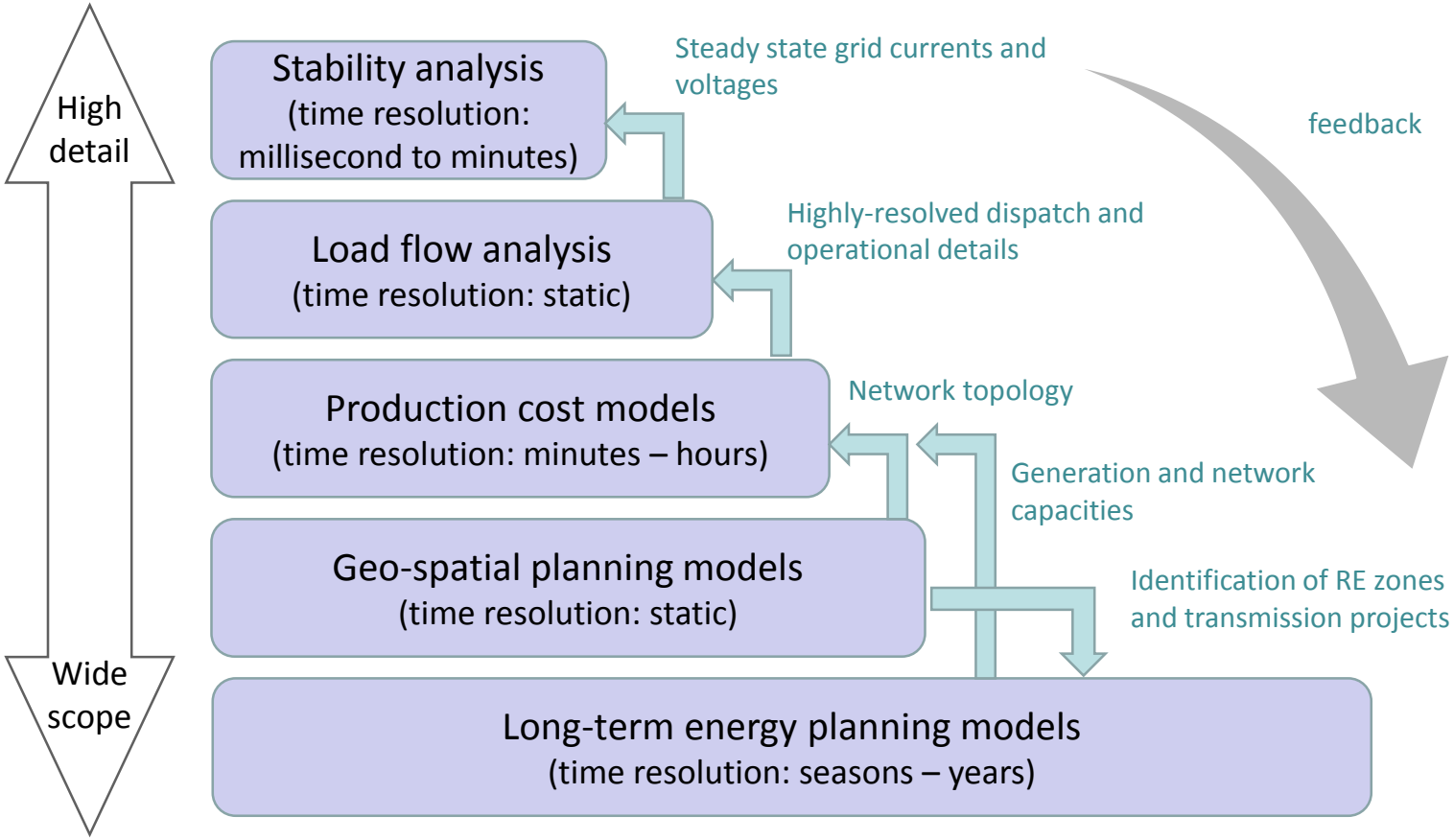
AVRIL objectives

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



→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

The technical solutions

Smart grid technologies

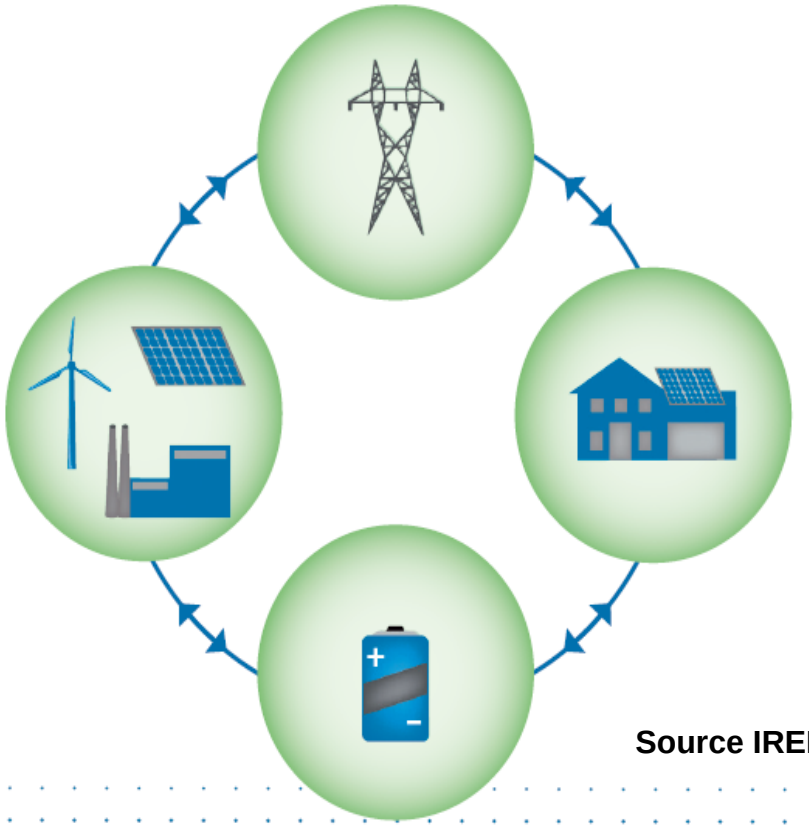
- ✓ Advanced control systems
- ✓ Distribution automation
- ✓ Smart / grid friendly inverters
- ✓ Smart advanced metering
- ✓ Data collection technologies
- ✓ Forecasting

Energy storage solutions

- ✓ Batteries
- ✓ Flow Batteries
- ✓ Flywheels
- ✓ Thermal storage
- ✓ Pumped hydro

Demand side options

- ✓ Demand response
- ✓ Electric vehicles
- ✓ Desalination
- ✓ Ice cooling systems

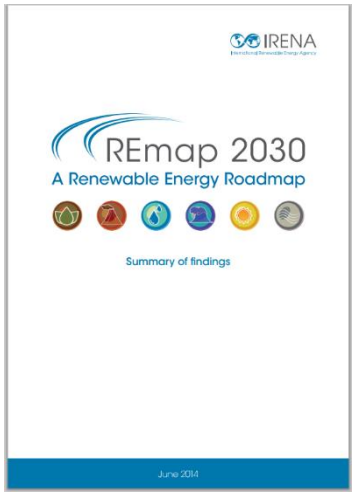


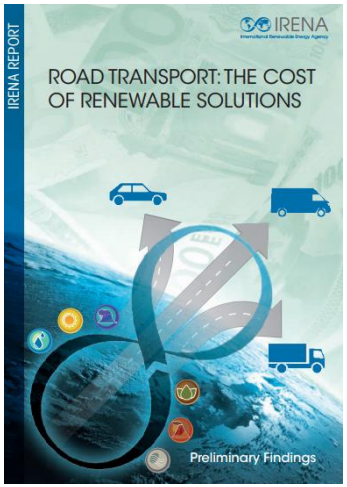
Source IRENA

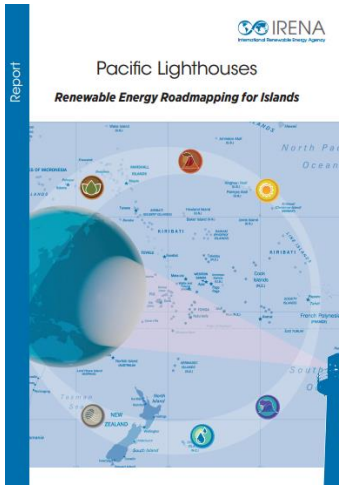
Market Design

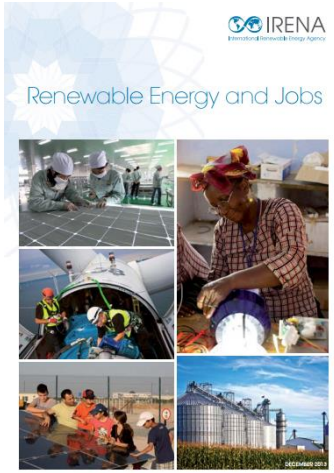
- Markets complement systems engineering
- Use ongoing data revolution for power system management
- Pricing reflecting cost
- Wholesale vs retail prices – very different decision environments
- Need for capacity markets – or not?
- Valuation of grid services (frequency and voltage control, etc)
- Perfect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

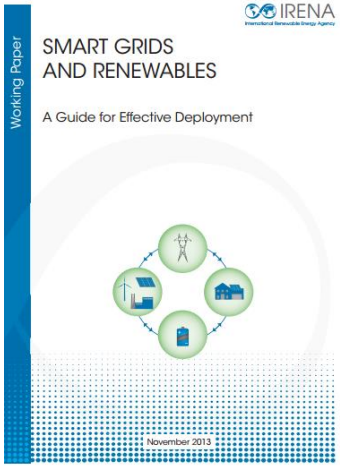
Thank You!











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