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Renewable energy resources as assets in the revised SNA

Robert Smith, Midsummer Analytics

Grzegorz Peszko, World Bank

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Renewable energy resources as assets: scope and motivation

- Renewable electricity (hydro, wind, solar, geothermal) resources are economically too important to omit from national balance sheets
  - Fastest growing sector of electricity sector
  - Already account for 30% of global electricity generation according to the International Energy Agency
  - Hydro resources alone likely worth trillions of dollars worldwide according to pilot empirical work by the World Bank*
  - Solar, wind, geothermal were mostly of low or zero asset value (in 2017) due to subsidization, high costs of capital, low carbon prices and curtailment of development to protect thermal power plants
    - This will change quickly as markets evolve and capital costs continue to fall and climate policies internalize external costs of fossil fuels
- When resources become productive to this extent, the SNA asset boundary merits reconsideration
  - Not to do so risks creating an imbalance between the production accounts and the capital accounts
- Non-renewable energy resources are already recognized as assets in the SNA because of their economic importance

*See: Smith R., A. Ilas, J. G. Inon and G. Peszko, 2021, "Renewable Energy: Unaccounted Wealth of Nations", in *The Changing Wealth of Nations 2021: Managing Assets for the Future*, Washington: The World Bank.

Current treatment of renewable energy resources in SNA and SEEA-CF

- Neither the SNA nor the SEEA defines a complete and internally consistent approach to renewable electricity resources
- SNA has relatively little to say
  - What is said implies renewable energy resources are not assets because ownership rights cannot be enforced
    - Yet, ownership rights clearly are exerted by both public and private entities
- SEEA-CF treatment is extensive but incomplete
  - Renewable energy resource values are expected to be captured in the value of the associated land: “Opportunities to earn resource rent based on sources like wind, solar and geothermal should be expected to be reflected in the price of land” (SEEA-CF ¶5.228)
  - Ignores renewable energy production that occurs on land without other economic value and the fact that renewable energy markets are rapidly evolving

Exploring the assumptions behind the SEEA-CF treatment of renewable energy resources

- Several issues regarding the SEEA-CF's position that renewable energy resource values are captured in land values deserve can be identified:
  - Property rights often do not include the rights to the economic benefits flowing from any associated renewable energy generation
  - Much land associated with renewable energy production has no economic value in the SNA
  - Markets for renewable energy production are rapidly evolving

Property rights to renewable energy resources

- Property rights to renewable energy resources are mostly public
  - Hydro resource rights are public in all cases of any significance
    - The same is true of off-shore wind
  - Solar/wind production rights on public land are also public
  - Geothermal resources are almost universally claimed by governments as part of mineral rights
    - Even in the U.S., where mineral rights are traditionally acquired with purchase of surface land, mineral rights are often severed from private land
- Only rights to solar/wind production on private land (e.g., solar rooftop or windmills on farmland) vests in private hands
  - Note that utility-scale solar/wind (accounting for most current growth in installations) is generally on public land (e.g., former surface mines, otherwise contaminated lands or deserts) rather than private land

In most instances, property rights are such that renewable energy production will not influence the value of land recorded in the SNA

Land value in the national accounts

- SNA only values private land or land associated with public infrastructure or buildings
  - Public land with no “productive” use is not recorded (e.g., forest, rivers, lakes, seabed, deserts, barren land, etc.)
- Thus, only in the case of renewable electricity production on private land is there an SNA land value that could be influenced
  - Production of all hydro, geothermal, off-shore wind and on-shore wind and solar on public land occurs on land not generally valued in the SNA
  - For example, the UK Crown will earn billions of pounds from off-shore wind farms on seabed that has no value on the UK balance sheet
- Only solar/wind production on private land is apt to influence land values captured in the SNA

Most renewable energy production occurs on land that is not valued in the SNA

Renewable energy resource values and land prices

- In theory, where property rights vest in land owners, property values should reflect value of renewable energy resources, as SEEA-CF suggests
  - In practice, applies only to solar/wind on private land
- Empirical evidence in the peer-reviewed literature shows inconsistent capturing of solar/wind resources in property values
  - Studies show that property values increase in some cases where renewable energy production occurs, but the amount of increase is inconsistent across markets
    - Some studies show little to no net increase in value (above the fixed capital cost of the generation equipment) while others show more substantial net increases
    - Property values actually decrease in some instances where polices restrict ability of landowners to capture rents
- Such inconsistent capturing of values reflects the evolving legal/regulatory contexts and technology/cost structures that characterize renewable energy markets

Private land values inconsistently reflect solar/wind resource values

Summary of concerns with existing material in SNA and SEEA-CF

- SNA treatment is limited and unclear
- SEEA-CF treatment is clear but applicable, even *in theory*, only in restricted circumstances (production of solar/wind electricity on private land)
  - Land prices appear to inconsistently capture renewable energy values, so SEEA-CF approach would not be appropriate *in practice* even for solar/wind on private land
- The SEEA-CF treatment is *not applicable at all* for hydro, geothermal, off-shore wind and utility-scale solar/wind, which account for the majority of production

An alternative approach is required

Recommended approach to renewable energy resources as assets

- We recommend renewable energy resources be recognized as a new category of non-produced, non-financial assets in the revised SNA
- Requires addition of a new natural resource category to the SNA
  - To avoid confusion, the current category “Mineral and energy resources” should be renamed (see table)
- For consistency, the SEEA-CF asset classification should be similarly revised at the time of its next update

Proposed new classifications of natural resource assets in the SNA and SEEA-CF

SNA	SEEA-CF
Land	*Mineral resources*
Mineral reserves	*Non-renewable energy resources*
Non-renewable energy resources	*Renewable energy resources*
Renewable energy resources	*Land*
Non-cultivated biological resources	*Soil resources*
Water resources	*Timber resources*
Other natural resources - *Radio spectra* - *Other*	*Aquatic resources*
	Other biological resources
	Water resources

Note: New asset categories are shown in green and renamed categories are shown in red.

Defining renewable energy resources

- We propose to follow the recommendations of the United Nations Framework Classification for Renewable Energy Resources to define renewable energy resources
- Renewable energy resources are the cumulative energy captured by existing renewable energy projects (e.g., hydro stations and wind farms) over their lifetimes
  - This is consistent with the SNA/SEEA-CF definition of fossil fuel resources, which are the energy stored in reserves recoverable under current economic and technological conditions
  - Renewable energy projects can be as small as a single roof-top solar installation or as large as major hydro station
- For example, solar energy resources in a country would be the sum of all solar energy captured by existing solar panels over their expected lifetimes
  - These resources could be measured in joules, GWh or barrels of oil equivalent
- As technology improves (e.g., better solar panels), a nation's renewable energy resources will expand by this definition
  - This is also consistent with fossil fuel resources, for which reserves also expand as extraction technologies improve

Recommended classification of renewable energy resources

We recommend the revised SNA recognize the following renewable energy resource types as assets

Renewable energy resources
Water energy resources
River water energy resources
Tidal energy resources
Wave energy resources
Solar energy resources
Wind energy resources
Geothermal energy resources
Other renewable energy resources

Advantages of the recommended approach

- Ensures consistency in treatment of all natural resource assets in the SNA
  - Other commercially important natural resources (fossil fuels, minerals, timber, etc.) are already recognized as assets
- Reflects the fact that the asset value of renewable energy resources is already large based on pilot empirical studies and is likely to grow substantially in the future

Possible disadvantage of recommended approach

- Could lead to double counting if some private land does in fact reflect the value of renewable energy resources
- Such double counting would likely be small, since it would apply only to solar/wind production on private land, which is the smallest production category
- Double counting could be avoided in practice by applying an approach similar to that used by national accountants to separate the value of land and structures from property prices

Valuation of renewable energy assets

- To value renewable energy assets, we recommend the residual value approach (RVM)
  - This approach is already recommended in the SNA and SEEA-CF for other natural resources
- RVM sets asset values equal to the discounted value of future rent streams
- Rent is estimated as revenues from resource production, less costs of production (net of subsidies), including normal returns to fixed capital and depreciation
- RVM requires choice of a discount rate and a decision regarding the expected pattern of future rents
  - Both SNA and SEEA-CF already offer guidance on these points for mineral and fossil fuel assets and we recommend applying that guidance to renewable energy resources with some exceptions (see later)

Alternative valuation approach

- Least-cost alternative is an alternative to RVM
- Least-cost alternative values resource rent as the difference between production costs using it and the next most economical approach
- Does not require information on revenues, which is helpful where those are not known or are known to be distorted by subsidies
- Has been applied in the past mainly to hydro resources
- Complex method, but may be more suitable than RVM where energy markets remain far from equilibrium because of subsidies or other government intervention
  - Since deregulation of electricity markets began in the 1990s, such distortions are less-and-less common

RVM – conceptual and practical issues

- Conceptual
  - Markets need to be close to equilibrium
    - Renewable energy markets remain distorted, but they are moving in the “right direction” and distortions are less severe than in past
    - Where distortions remain severe, least-cost alternative method can be used instead of RVM
- Practical
  - Some rent variables may be challenging to estimate with existing data, notably fixed capital costs
  - Future rent patterns
    - SNA and SEEA-CF recommend assuming constant future rent
      - Likely OK for hydro resources
      - Solar/wind/geothermal resource markets too dynamic to assume constancy however
        - Approaches may be required to model future revenues and costs

Recommended approach to recording ownership of renewable energy resources

- We are aligned with the recommendations of van de Ven and de Haan in their *Guidance note on Accounting for the Economic Ownership and Depletion of Natural Resources*
  - By this approach, ownership of renewable energy resources is partitioned between governments and resource companies according to the economic benefit each receives
- Where royalties are collected by governments (e.g., hydro resources), asset value would be shared between the public and private sectors
- Were governments do not extract royalty payments (e.g., much wind and solar production), assets would be mainly attributed to the business sector
  - This seems appropriate, as it reflects the fact that governments – for now anyway – relinquish their economics benefits from much (but not all) solar/wind production
- Whether governments will continue relinquishing most rights to solar/wind is a matter of debate
  - We see reason to believe they will not and evidence suggests they are already beginning to collect royalties (e.g., UK Crown)

Pilot study on value of hydro, solar and wind assets

- World Bank *Changing Wealth of Nations 2021*: Pilot accounts of renewable energy assets for 15 countries covering 1990-2017 using RVM to calculate resource rents from operating projects and asset value as NPV of future rents

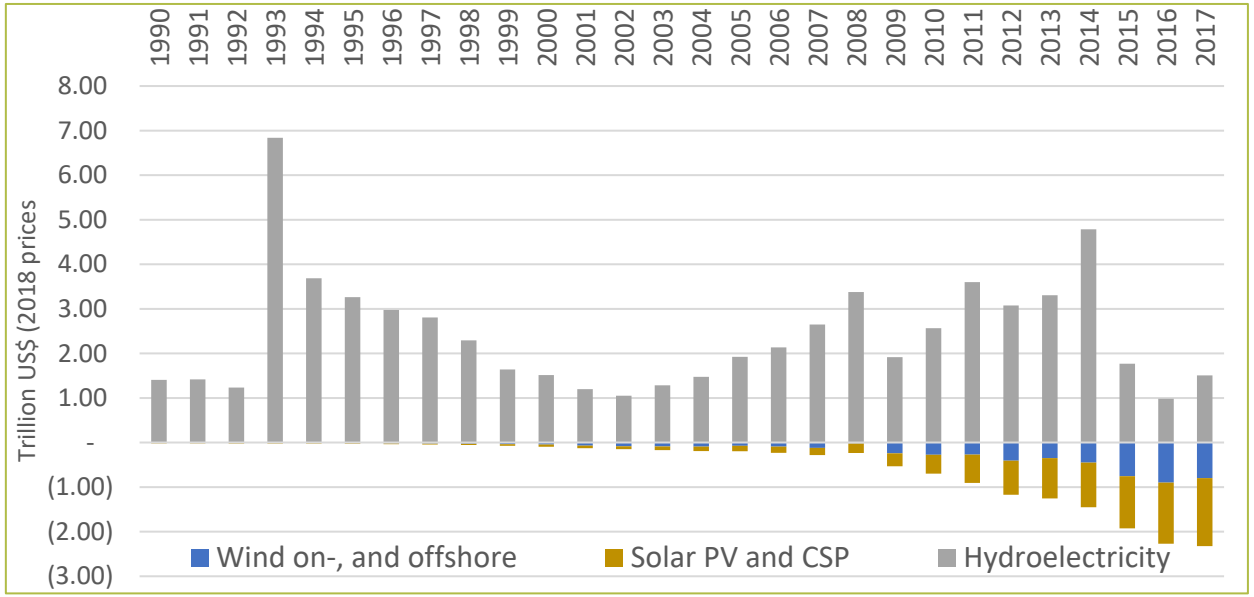
$$RR_t^i = TR_t^i - O\&M_t^i - (rK_t^i + \partial^i) \qquad V_t^i = \sum_{n=1}^{T} \frac{RR_t^i}{(1+r_g)^n}$$

- Potential value of renewable energy assets in 2 countries modelled under different policy scenarios

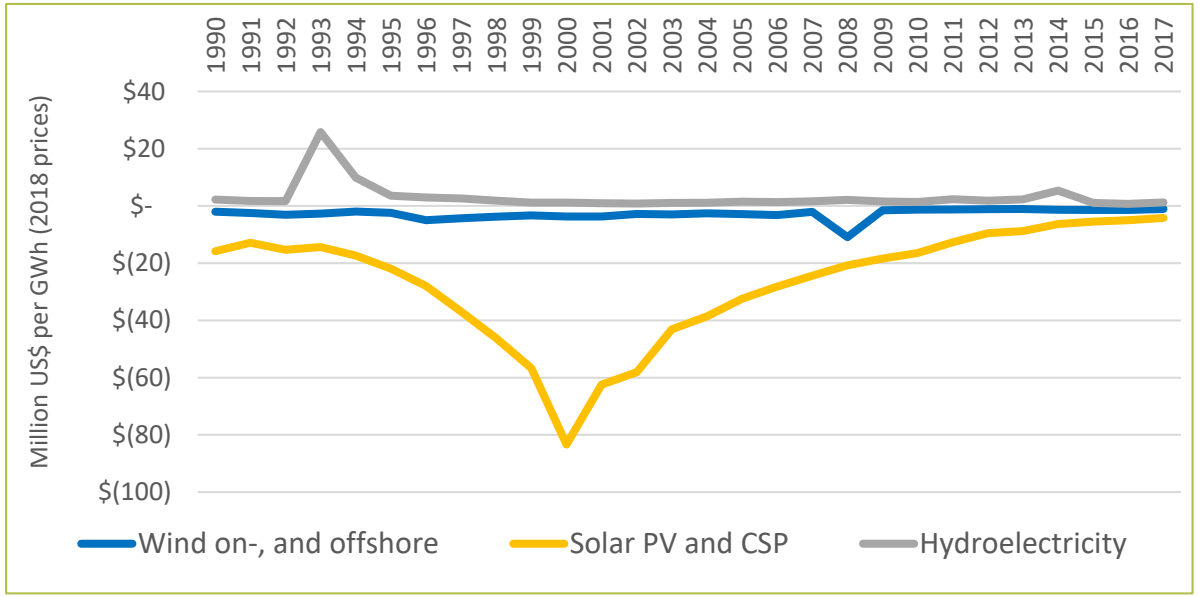
- *Changing Wealth of Nations 2.0 (planned)* – Full coverage of renewable energy assets in core accounts

Renewable energy assets are already valuable and will increase in value with market evolution and climate policies

Total renewable energy wealth in 15 countries 1990-2017

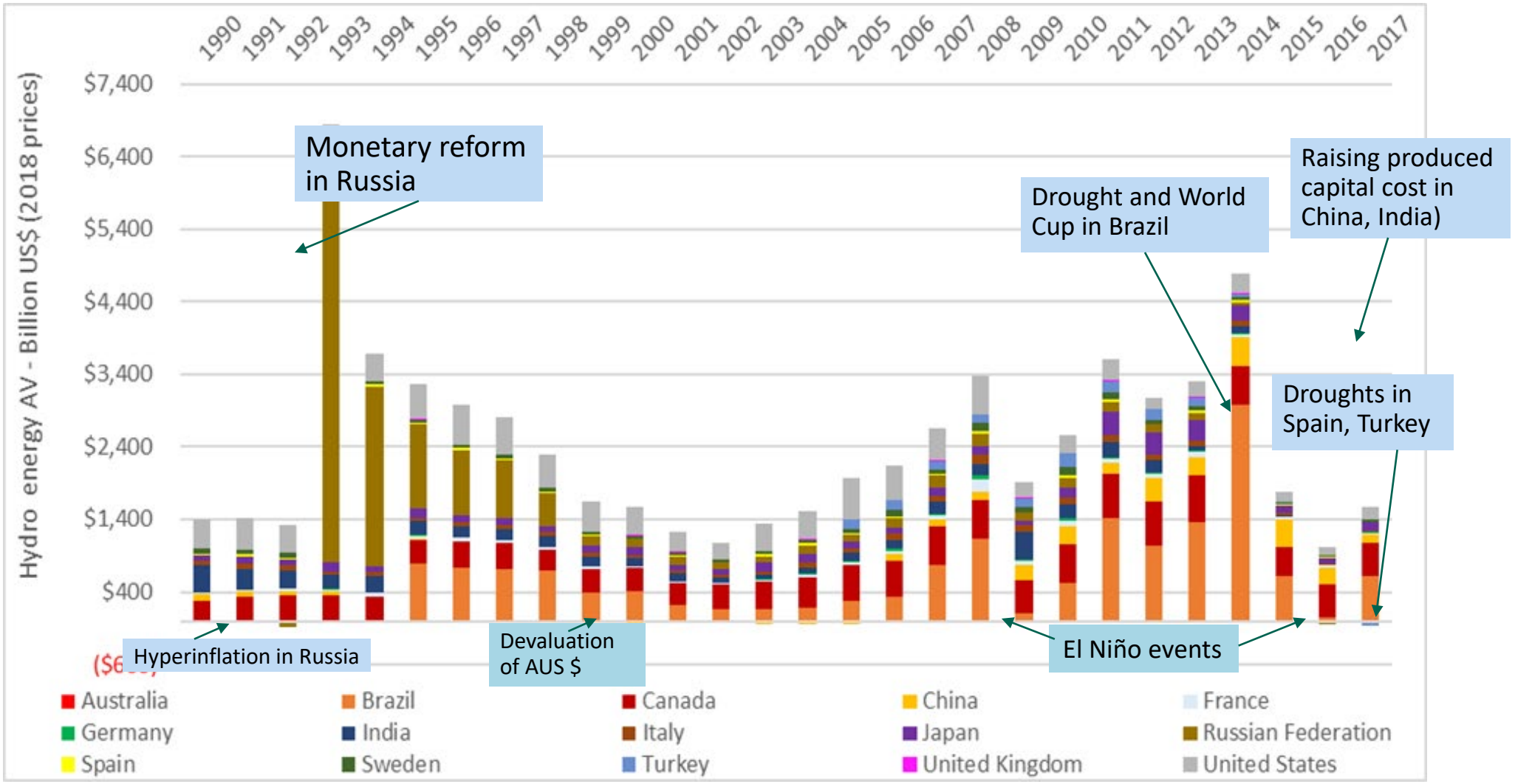


Average unit solar & wind wealth (per GWh) in 15 countries

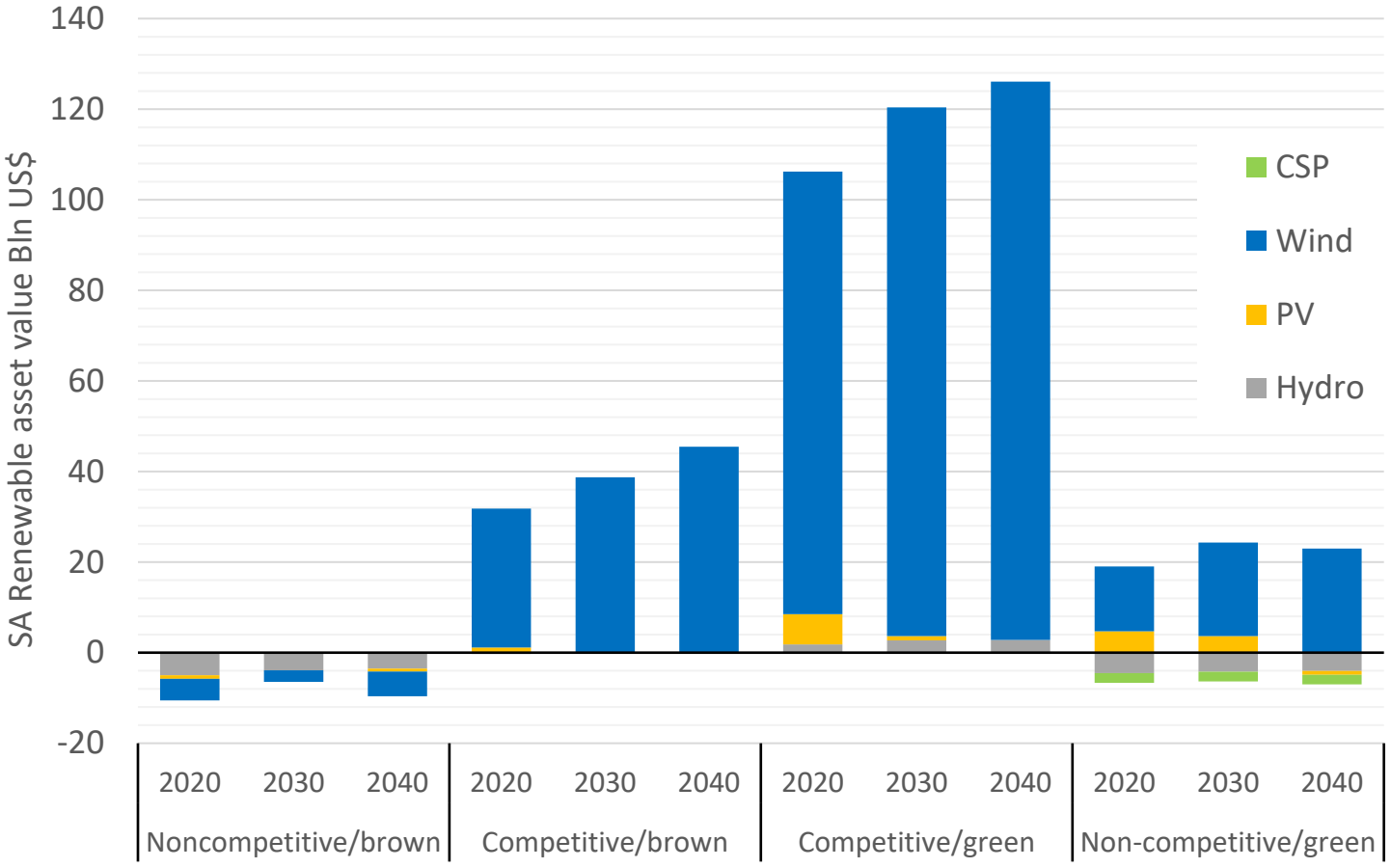


- Hydro assets have mostly positive, though volatile, values
  - Hydro assets in Canada and Brazil worth about the same as fossil fuel resources
- Solar and wind assets still have mostly negative values as nascent, subsidized but fast-growing industries with rapidly maturing technologies
- Unit solar and wind rents are approaching positive values

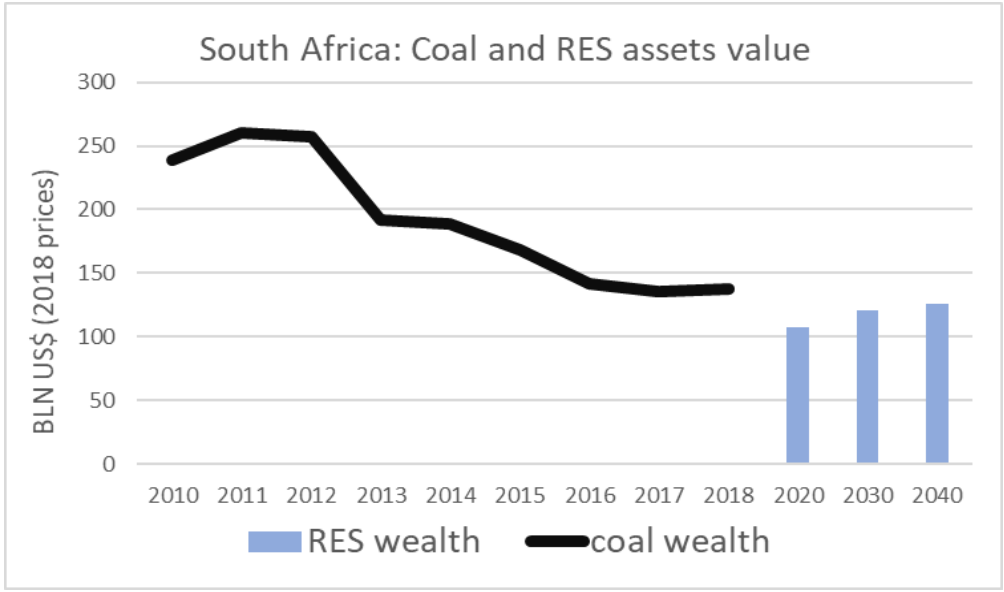
Historical hydro values fit well to the observed variations in electricity prices, generation levels and other major market events



Value of renewable energy assets can increase with efficient market and climate policies: Simulation of future renewable energy asset value in South Africa



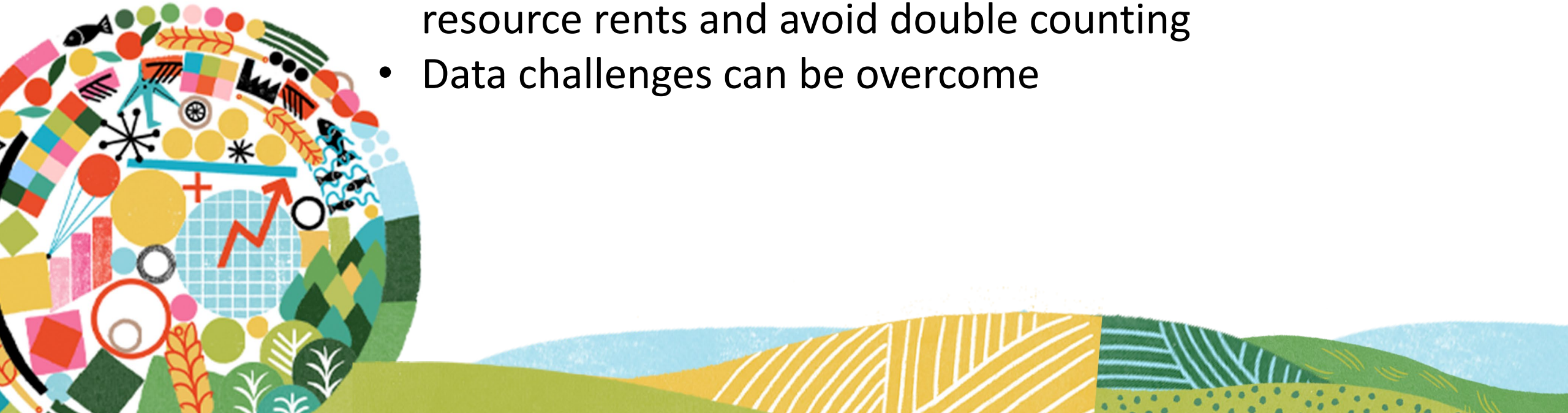
Fossil fuel vs. renewable electricity asset values under alternative policy reform scenarios



Competitive scenarios: allow premature retirement of non-competitive thermal power plants
Green scenarios: Carbon pricing

Conclusions from pilot study

- Proposed approach stress-tested on 70%-87% of globally installed renewable capacity
- RVM consistent with SEEA-CF and SEEA Energy can be applied to obtain meaningful, policy-relevant asset accounts
- RVM allows unpacking the value of fixed assets from resource rents and avoid double counting
- Data challenges can be overcome



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Thank you

Robert Smith, Principal
Midsummer Analytics
www.midsummer.ca
rob@midsummer.ca

Grzegorz Peszko, Lead Economist
Environment, Natural Resources, Blue Economy
The World Bank
gpeszko@worldbank.org