Namibia's Energy Future: Opportunities and Challenges

Prof. Stephen P. Holland

Namibia Energy Institute (NEI)

U.S. Fulbright Scholar

Namibia University of Science & Technology (NUST)

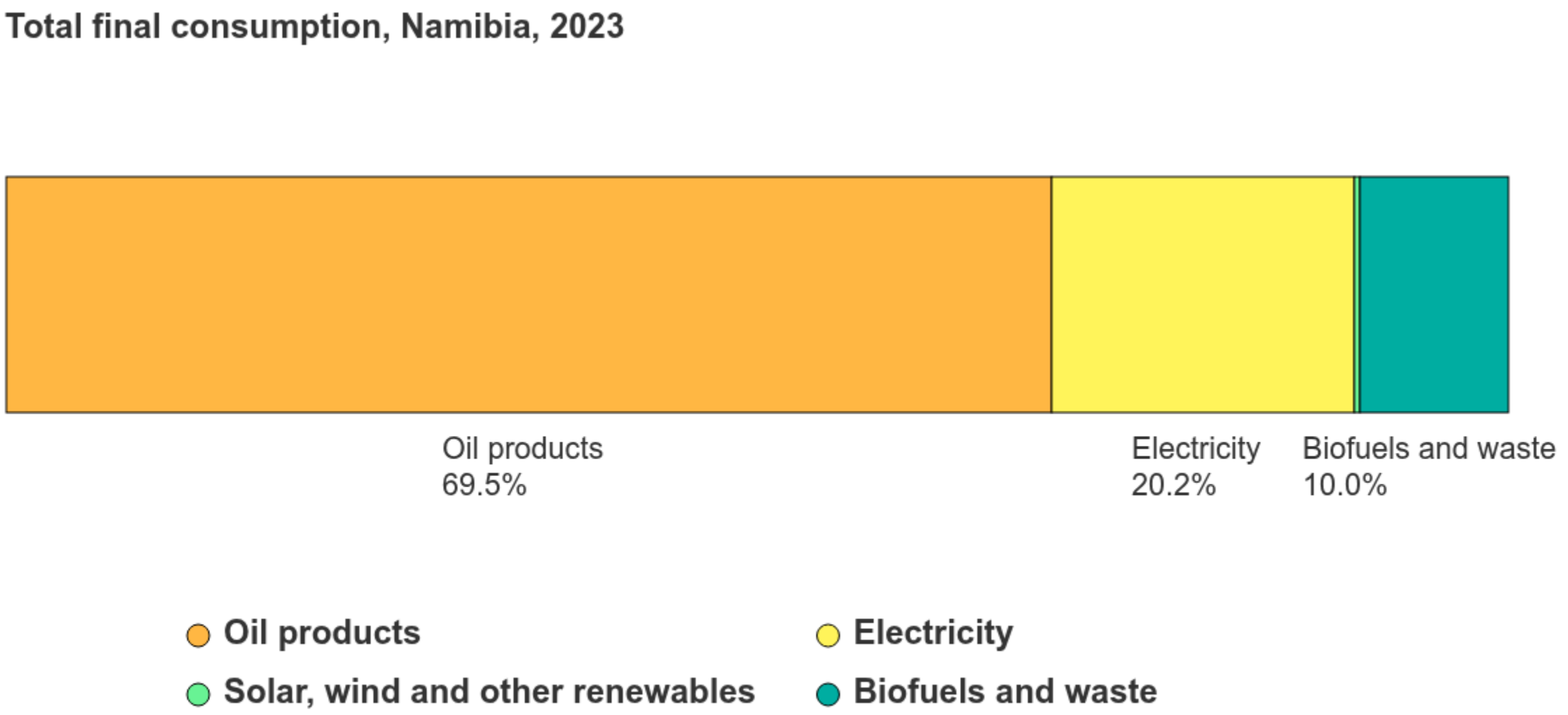
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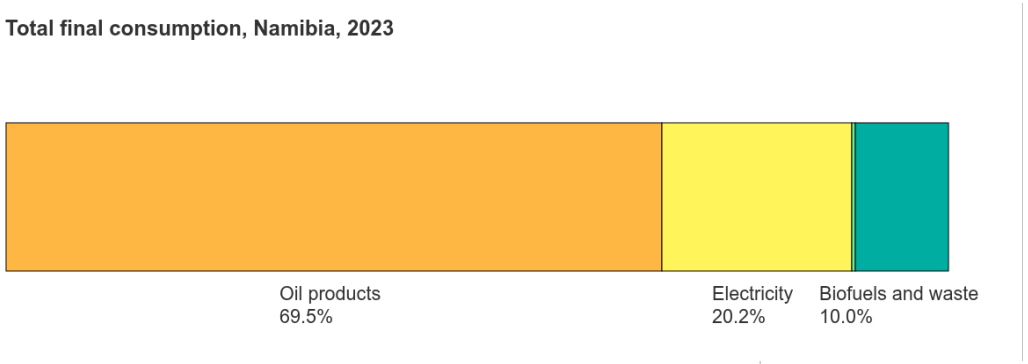
Namibia's Energy Future: Opportunities and Challenges

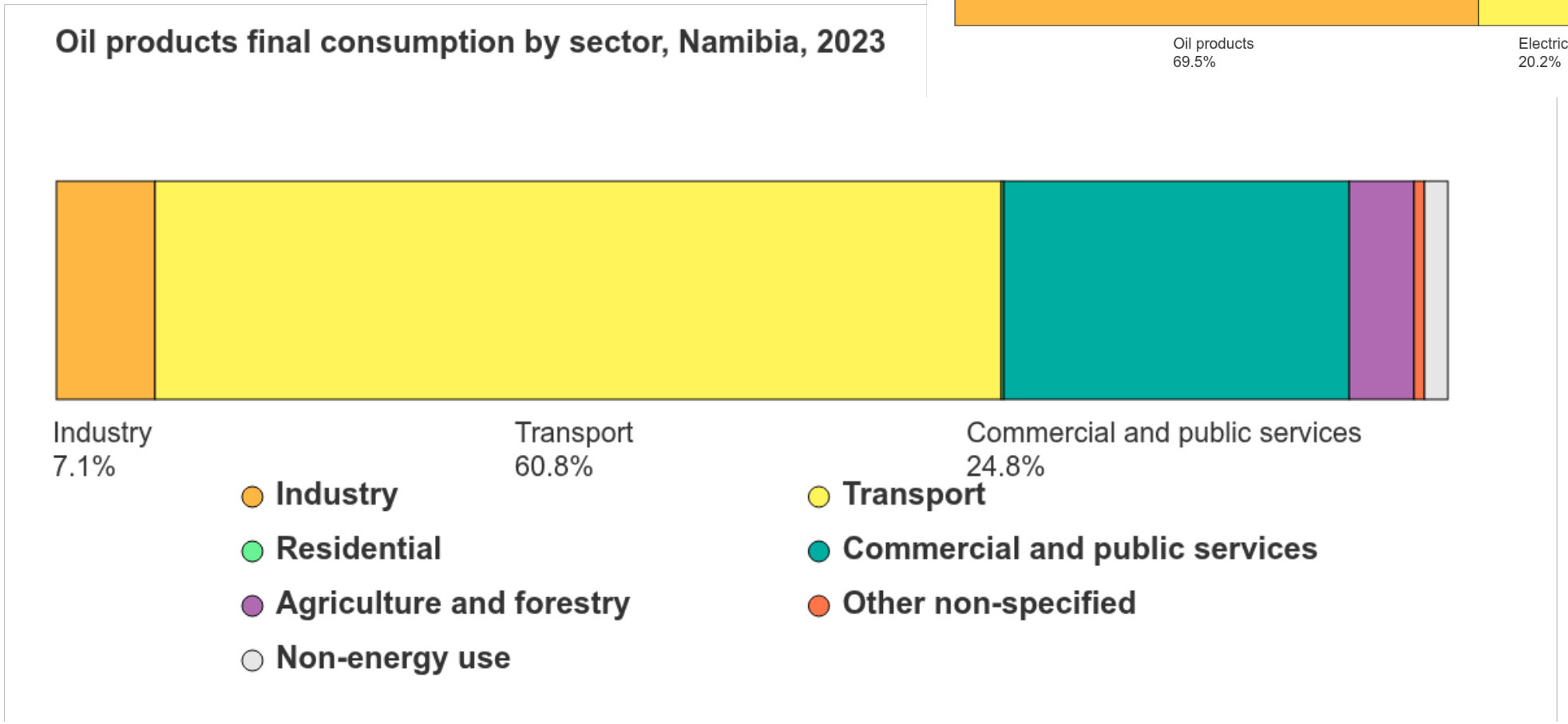
- Namibia energy today
  - Oil products consumption
  - Electricity generation
- World energy trends
  - Electrification
  - Renewables
- Namibian energy opportunities and challenges
  - Solar
    - Large-scale solar
    - Grid connected solar
    - Micro- or mini-grid solar
    - Green Hydrogen
  - Oil and gas
  - Nuclear

What types of energy does Namibia use?



How are oil products used?





100% of oil and oil products are imported.

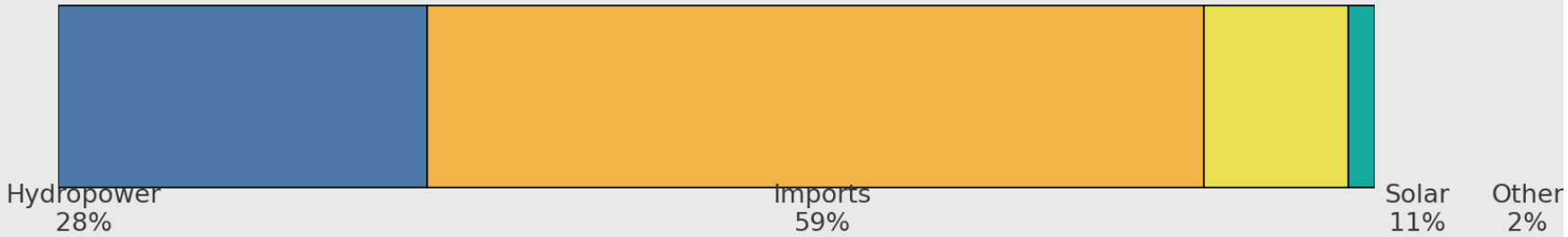
How is electricity produced?

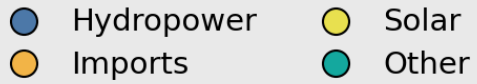


Total final consumption, Namibia, 2023

ency. Licence: CC BY 4.0

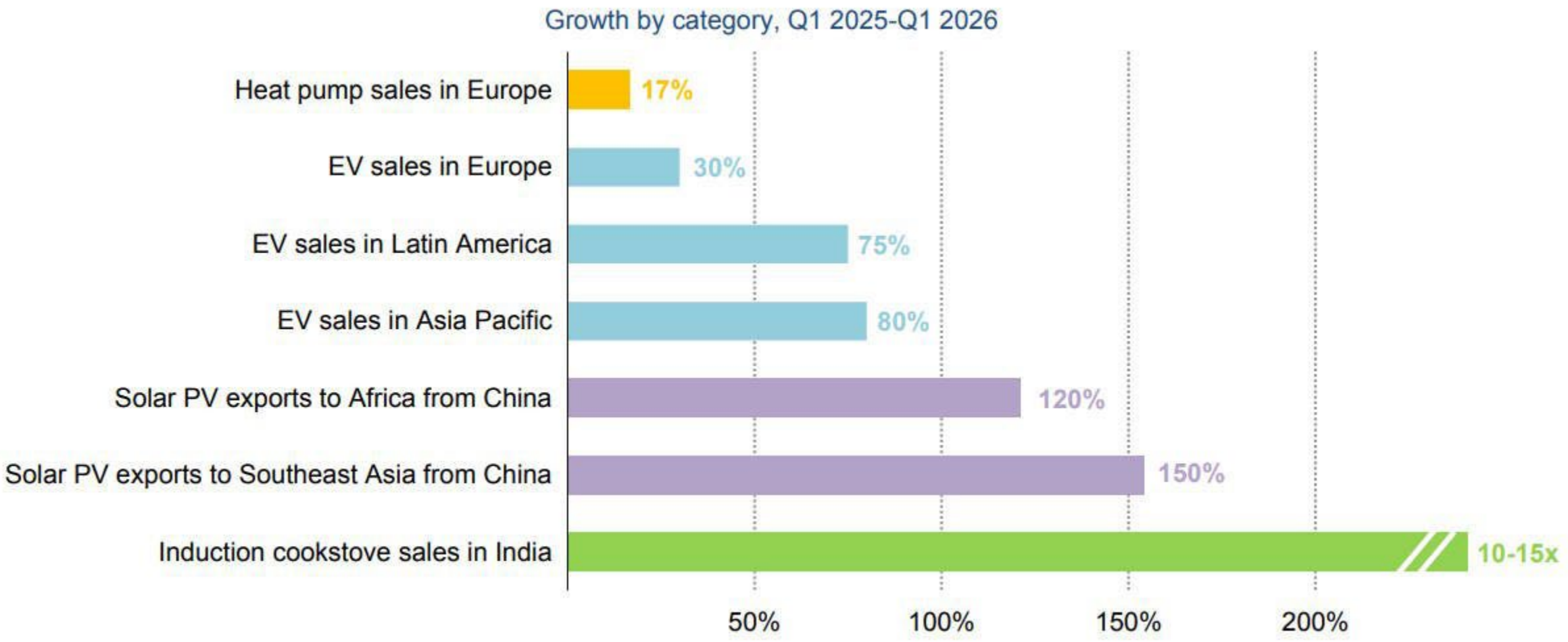
Electricity sources, Namibia, 2023





Source: Low Carbon Power (using Ember/IEA data)

The world’s energy future is electric

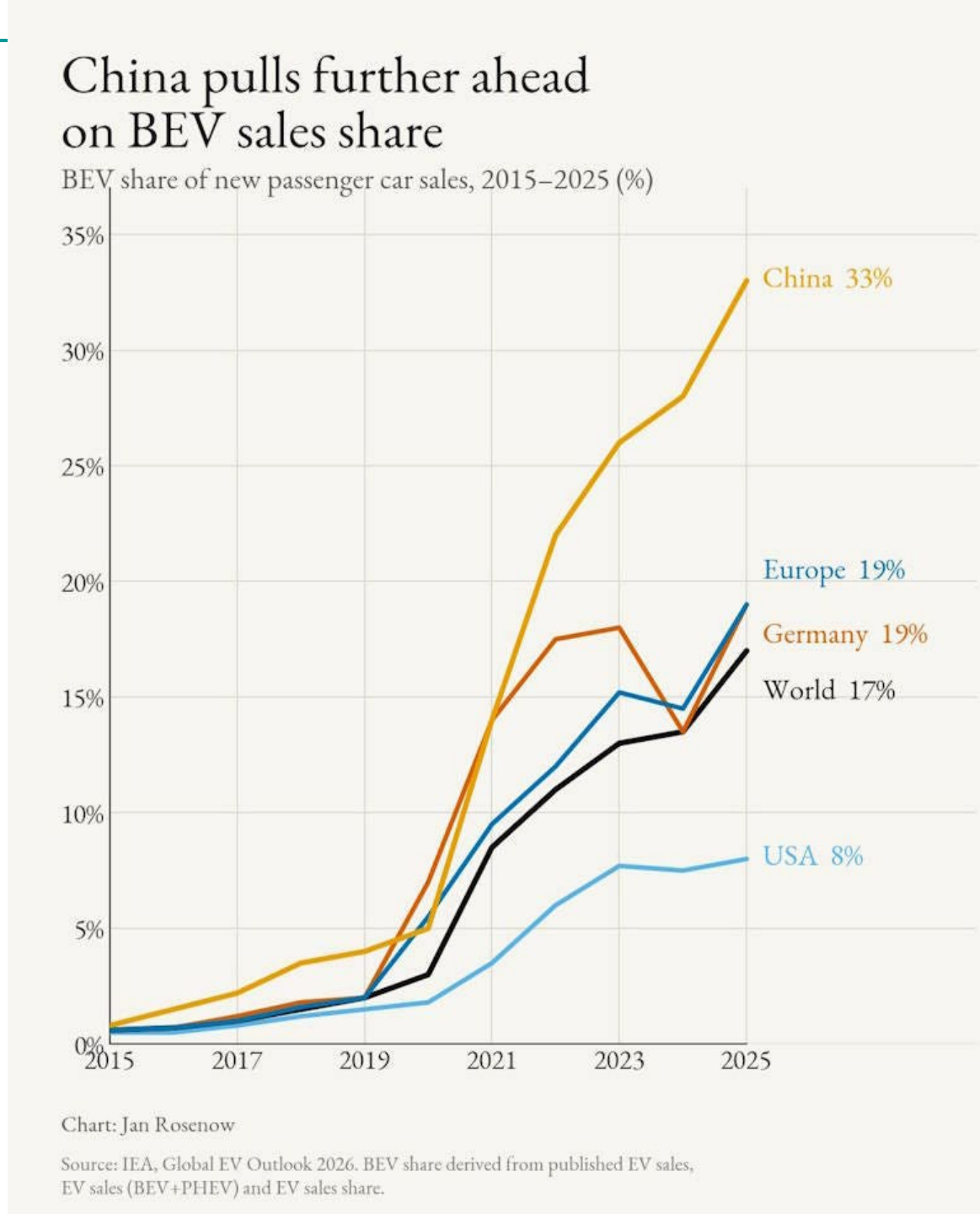


IEA. CC BY 4.0.
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The transportation future is electric

- The best new cars are electric
  - Most luxurious/high tech
  - Fastest
  - Cheapest
  - Most convenient

- Other transportation modes follow
  - Trains, buses, trucking
  - Air travel



Solar power growth: China's electricity generating capacity additions in 2024-25

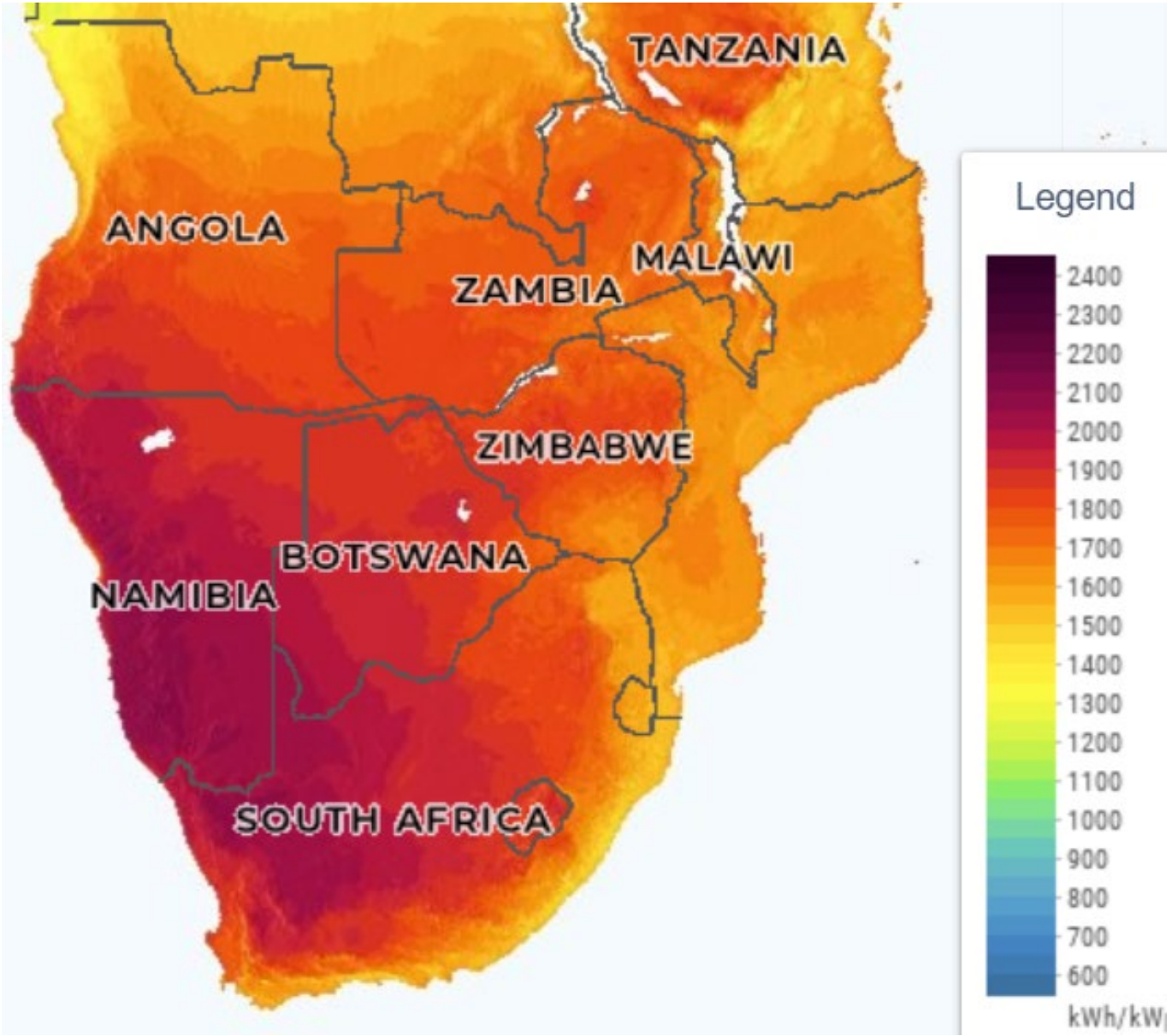
Technology	2024 New Capacity (GW)	2025 New Capacity (GW)
Solar	277.2	315.1
Wind	79.3	119.3
Hydropower	14.4	n.a.
Nuclear	3.9	n.a.
Thermal	54.1	n.a.
Total	**429.0**	n.a.

Technological advances in solar PV and batteries

- Photovoltaics (PV) technology
  - Wafers (100% Chinese production)
  - Cells (mostly China)
  - Panels
  - Installation (Mostly local content)
- Costs are falling rapidly
  - Costs fall as production grows
  - Each installation drives costs down
- Batteries
  - Costs and technologies are improving rapidly
    - Power density
    - Charging speed
    - Battery life
- Battery innovation is driven by cell phones, EVs, drones, etc.
  - Costs fall as production grows

Namibia's solar potential

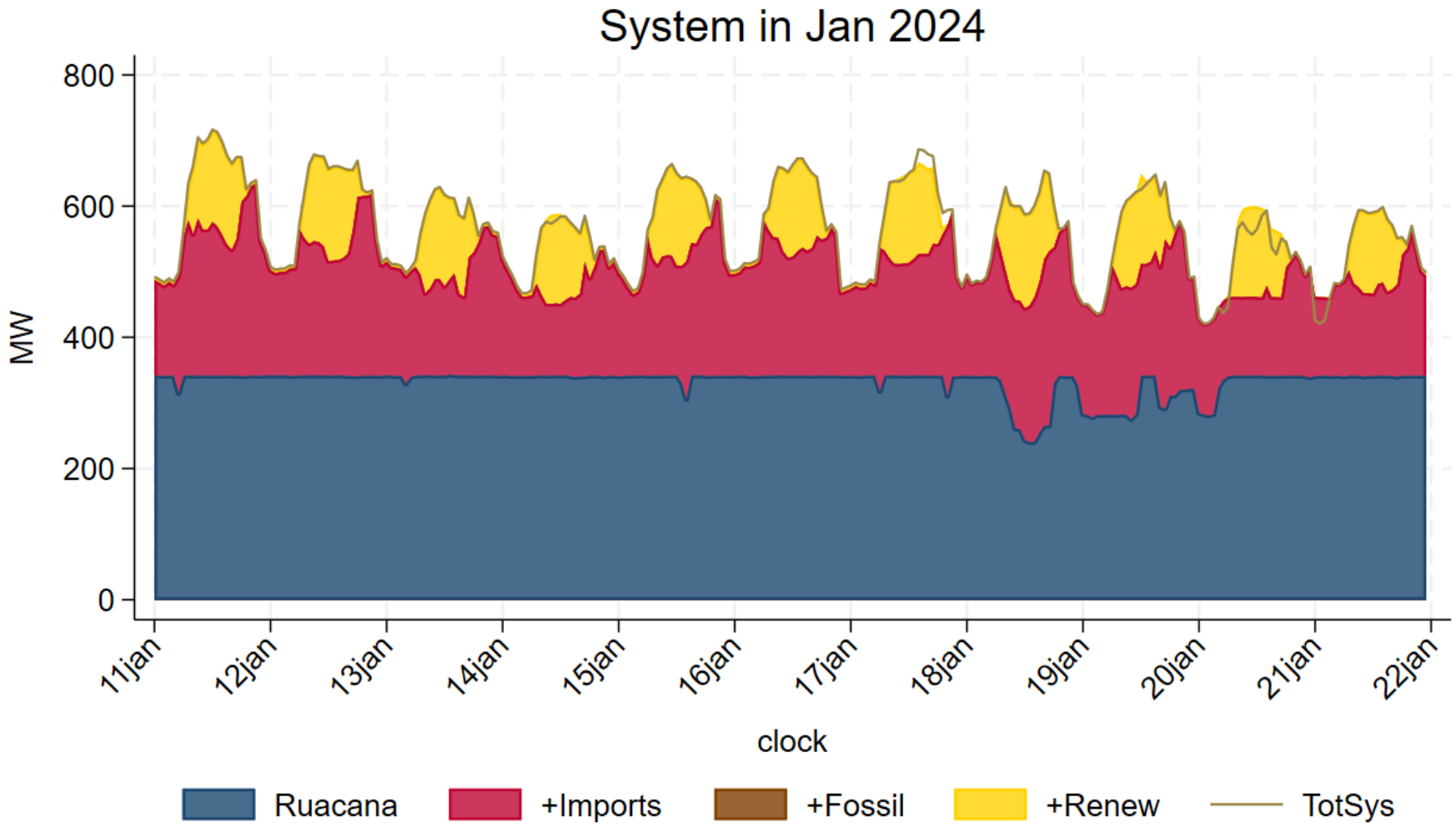
- Namibia has world's highest solar potential
  - 5.5 kWh/kW per day
  - Desert (no clouds)
  - High altitude (less atmosphere)
- Can wind complement solar?
  - Wind power requires steady wind
  - Namibia's wind resources are uncertain (coastal?)



Challenges in solar: Large scale

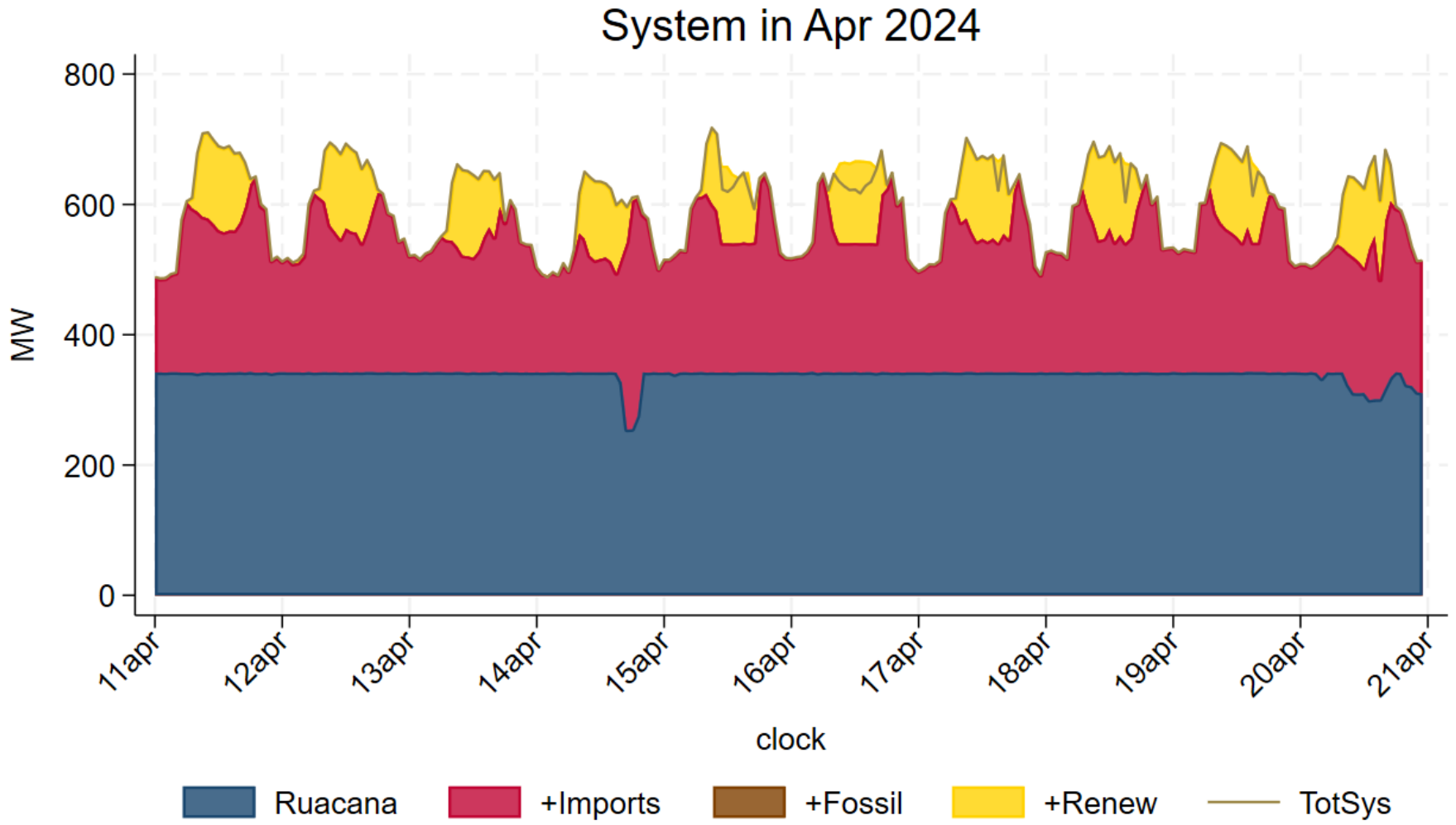
- Should Namibia build large solar?
  - Chinese plants are ~1 GW
  - US plants are 100 MW+
- Large-scale solar requires
  - Transmission
  - Grid balancing
- Challenge: Does peak usage coincide with solar generation?
  - In January, peak and solar do agree
  - In July, peak and solar don't agree
- If peak usage and solar generation don't coincide
  - Ramping can be extreme
  - Flexible resources required
    - Batteries or hydropower

Namibia's electricity system: January 2024



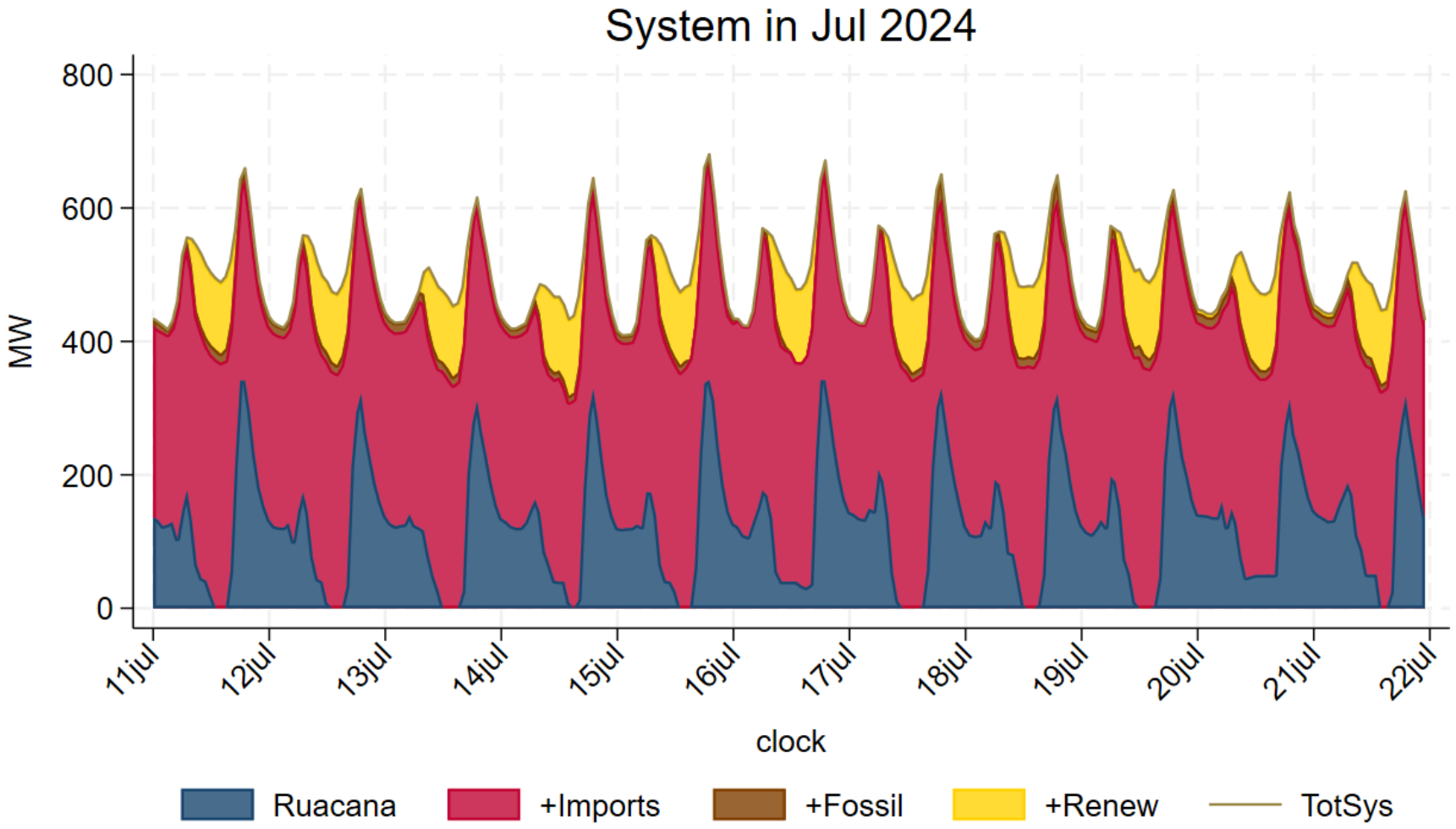
Solar integration is easy: Peak usage and solar coincide.

Namibia's electricity system: April 2024



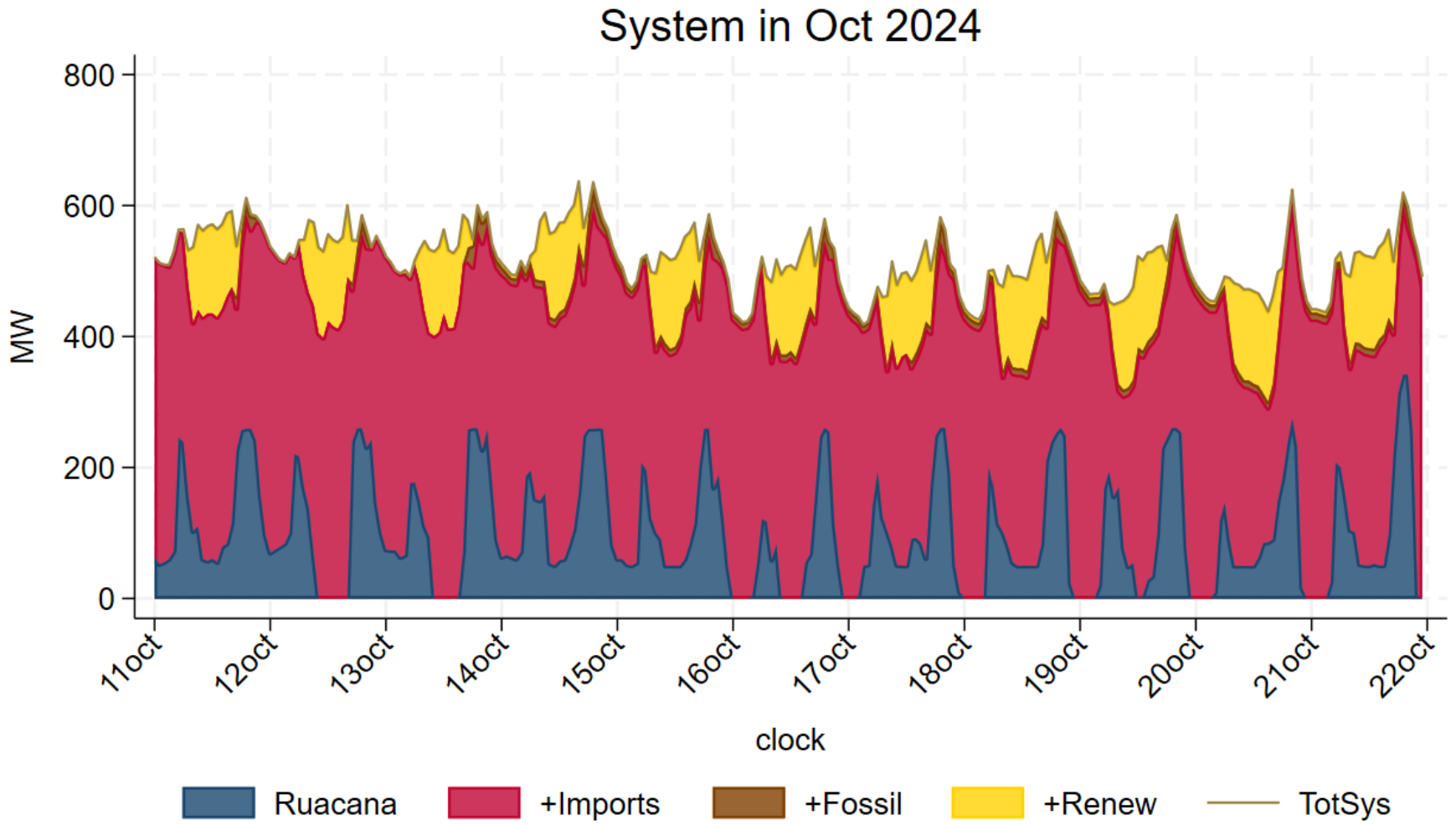
Solar integration is harder: Morning & evening use is greater.

Namibia's electricity system: July 2024



Solar integration is difficult. Morning and evening peaks!

Namibia's electricity system: October 2024

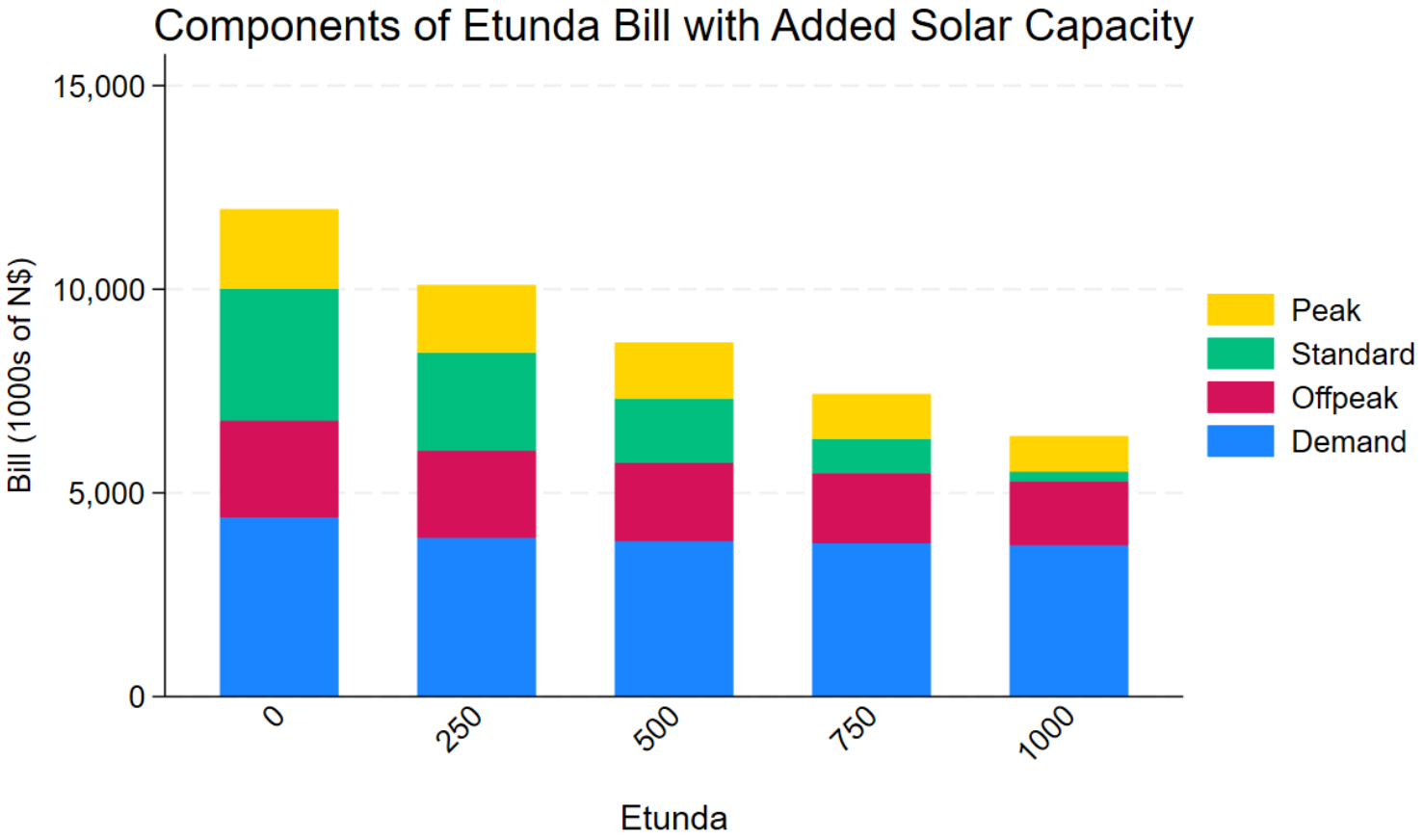


Solar integration is difficult. Evening peak needs batteries.

Opportunities in solar: Small scale

- Grid-connected solar "behind-the-meter"
  - Offsets grid electricity use
  - Can replace additional transmission and distribution
  - Receives "net metering" for electricity exported to grid
  - Example: Solar PV at Etunda Green Scheme is very cost effective
- Mini-grids
  - Not connected to the grid
  - Solar panels and multiple loads
    - Lights, computers, copiers, printers
  - Schools, clinics, police stations
- Micro-grids
  - A single load connected to solar
    - PV plus a light
    - PV plus a borehole
    - PV plus a cellphone charger

Solar PV in Etunda Green Scheme: 2 year payback(!!)



Etunda Annualized electricity bill		
PV (kw)	Annual Bill ($N)	Payback (years)
0	11,960,827	.
250	10,102,238	1.9
500	8,691,617	2.1
750	7,427,258	2.3
1000	6,389,478	2.5

Notes: In N$ for 2025-26 tariff rates. Payback in years assumes N$14,000 per kW solar PV cost and N$7500 per kWh Battery cost.

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Micro-grids





Mini-grids at primary schools

Panels and container



Controllers and inverters





Lithium-ion batteries

Mini-grids at primary schools







Opportunities and challenges with primary school mini-grids

- Benefits of solar
  - Light is hugely beneficial in education
  - Aids in teacher retention
  - Cheaper/easier than grid connection
- Challenge: maintenance
  - Systems need regular maintenance
  - Repairs require technical knowledge and expensive parts
- Challenge: not "real" electricity
  - Cannot cook or iron
  - Refrigeration unreliable
  - Will mini-grid slow down a real grid connection?
  - Can the transition to grid-connection be clarified so that REDs want to connect mini-grids?

Solar electricity and green hydrogen

- Green hydrogen is produced by electrolysis using solar electricity
  - H2 is "energy carrier"
- Hydrogen competes with batteries for most uses
- Batteries are winning
  - for cars, buses, trucks,
  - grid-scale electricity storage,
  - small-scale electricity storage
- Green hydrogen is primarily a "niche" product
  - Green iron/steel
  - Green ammonia
- Green hydrogen is for sectors that are hard to decarbonize

Opportunities and challenges: Oil and gas

- Off-shore Orange basin could contain 11-20 billion barrels of oil equivalent
  - Valued up to ~$1 trillion USD
    - 50 years of Namibia's GDP
- Challenge: access is difficult
  - 200 km from shore
  - 2 km of water to ocean floor
  - 2 km of drilling below ocean floor
- Ultra-deep-water drilling is very expensive and risky
- Limited local impact
  - 100 workers on FPSO at any time
  - No oil will reach Namibia's shore
- Oil production is not sustainable
  - A sovereign wealth fund (Welwitschia Fund) can make wealth sustainable

Opportunities and challenges: Onshore gas

- Gas exploration in Kavango is showing promise
  - Gas in Kavango cannot access world markets
  - Oil companies want access to world markets
- Gas can be used for electricity generation
  - Quick ramping
  - Works well with solar electricity
  - Not renewable, but relatively clean
  - Generation capacity and transmission lines would be required
- Can Kavango gas be developed for local electricity generation?

Opportunities and challenges: Uranium

- Namibia is one of world's largest uranium producers
  - Mining, milling, leaching, etc.
  - "Yellowcake" is exported
- Can nuclear power be part of Namibia's energy solution?
- Yellowcake conversion, enrichment, and fuel fabrication is done abroad
  - National security risks
- Nuclear power plants are expensive
  - China: build many big reactors
  - US: plan to build many small, modular reactors
  - Costs remain stubbornly high

Conclusion: Opportunities and challenges in Namibia's energy future

- Solar power
  - Utility-scale solar
    - Seasonal difficulties
  - Grid-connected solar
    - Needs net metering
  - Mini-grid solar (not grid connected)
    - Great for remote locations
    - Needs a transition plan
  - Micro-grid solar (single uses)
  - Green-hydrogen solar
    - Only has niche uses

- Oil and gas potential
  - Enormous reserves
  - Costly and risky to access

- Uranium mining & nuclear power
  - Security risks
  - Expensive power source

Thank you!

Namibia's economy

