Collaboration on Energy and Environmental Markets

Open source data and tools for assessing the renewable energy potential of the Pacific Island Countries and Territories

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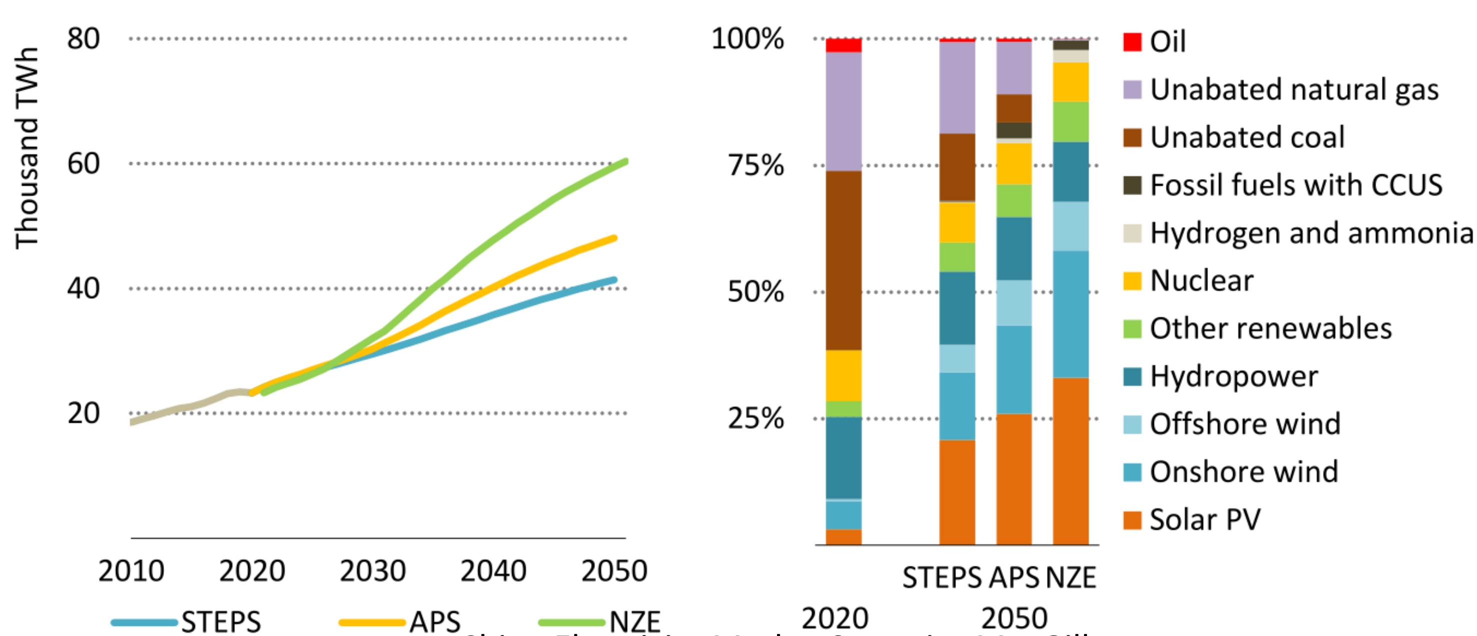
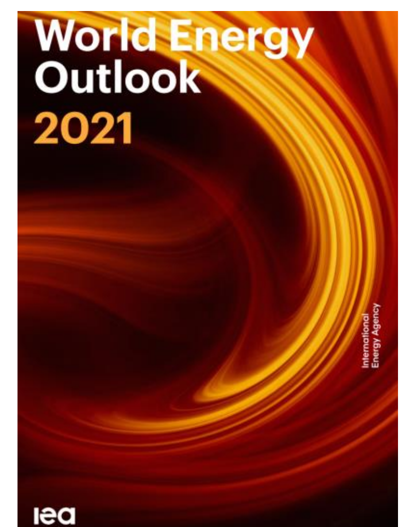
Globally, a mostly shared electricity industry destination

- a future global sustainable electricity sector will be larger, more diverse, increasingly variable renewables dominated
- with all countries having to contribute as appropriate and possible to transition
- and likely regional variations in generation mix, industry size; lessons from others but every jurisdiction still needs to find its own ‘best’ path

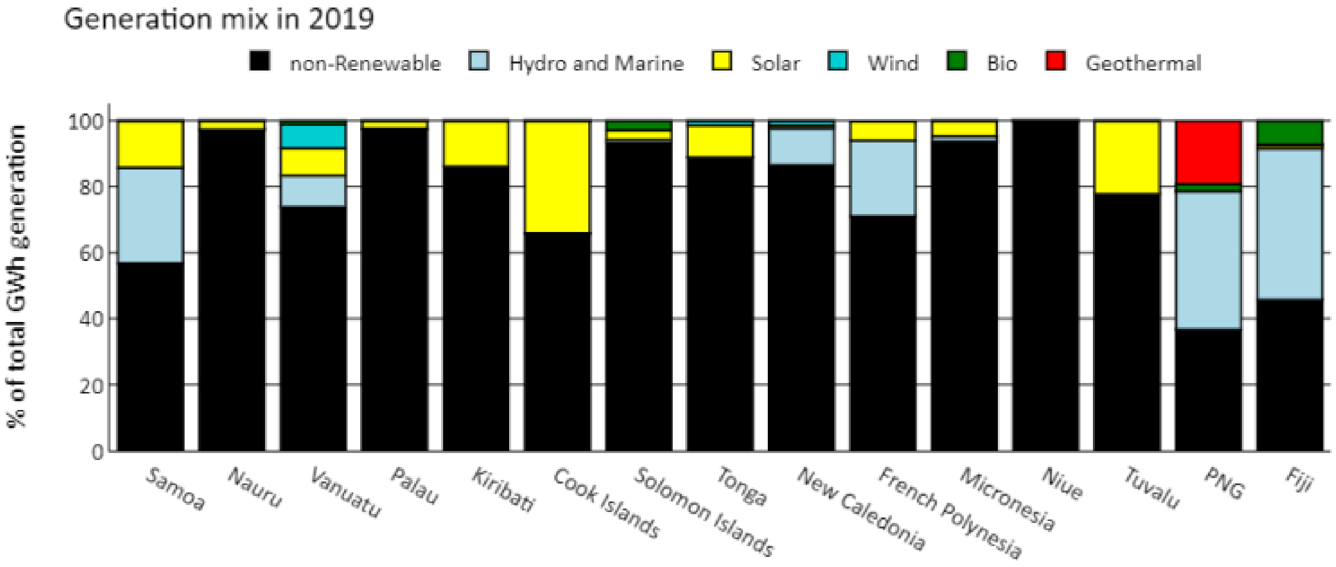
Figure 4.20 ▷ Global electricity demand and generation mix by scenario

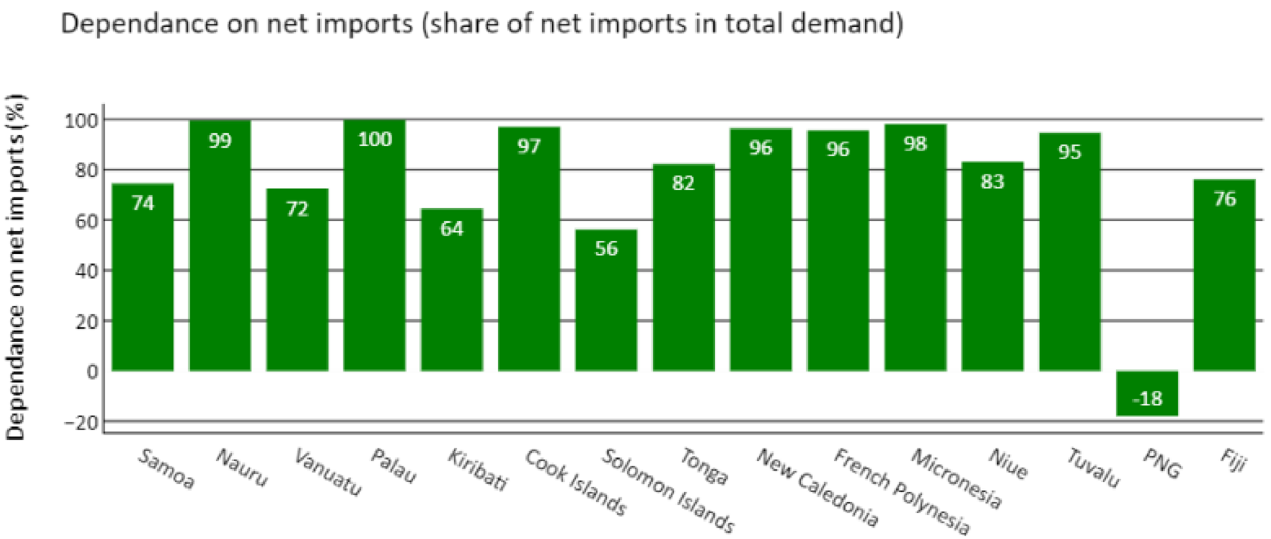




From very different starting points, and opportunities

- Including industry size, generation mix, current non-electricity sector energy use

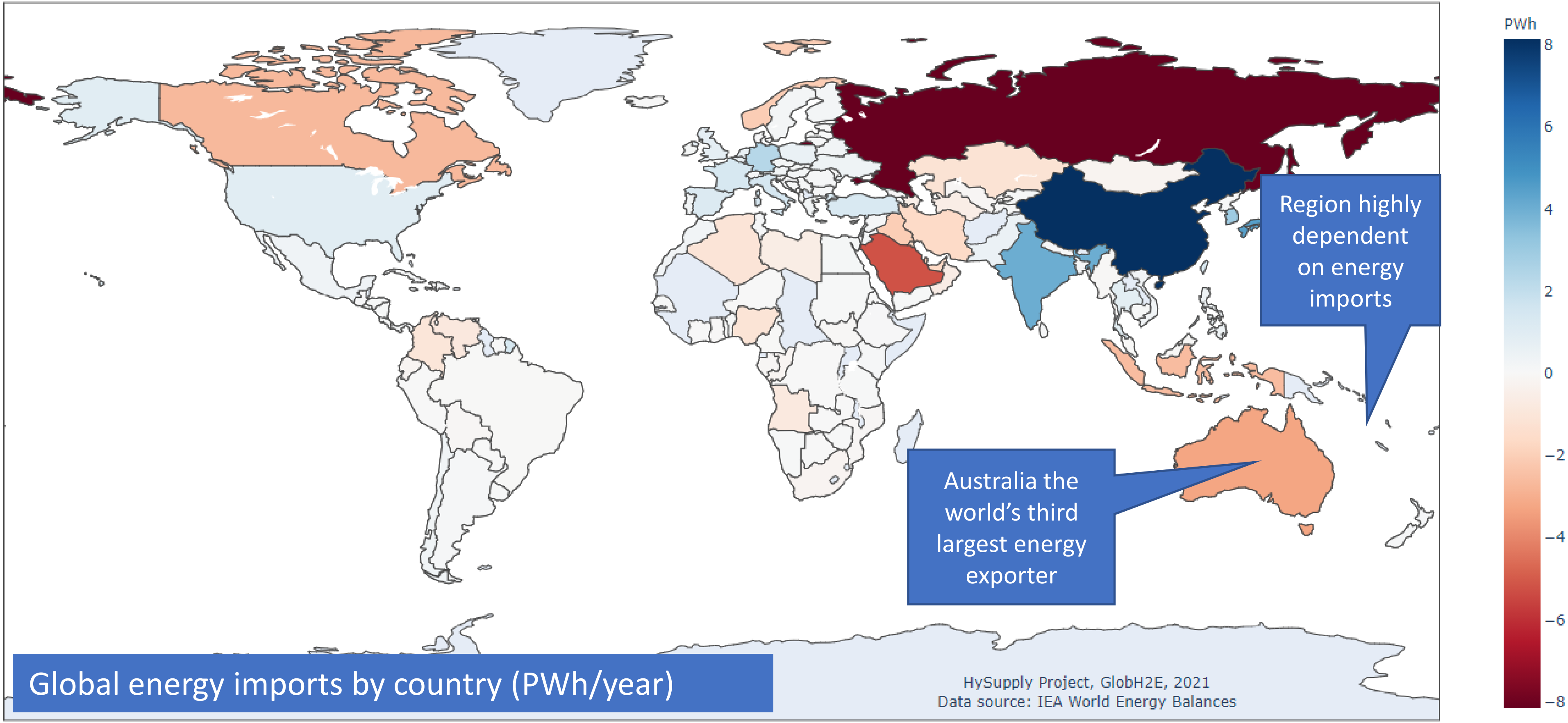




Source: Our world in data

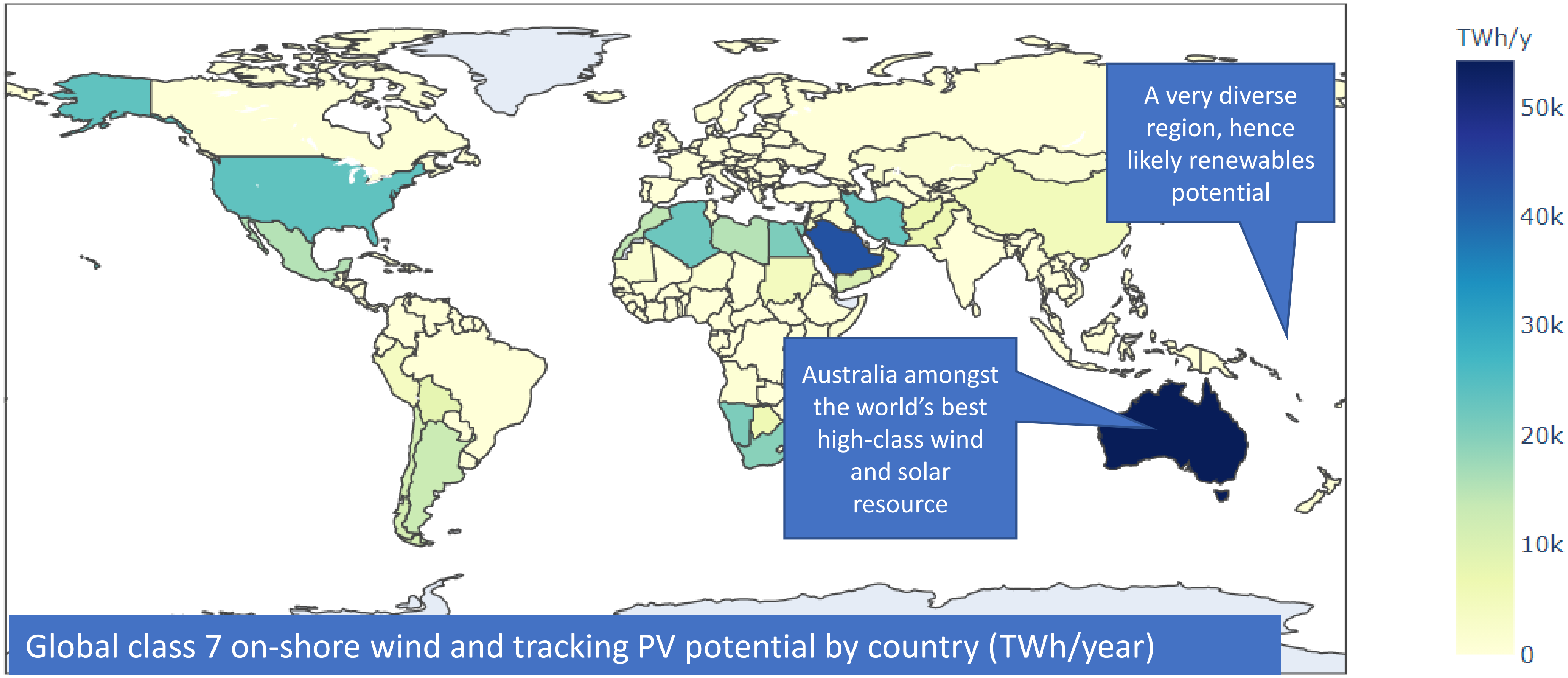
Current global energy trade

- Largely an outcome of the availability of easily extracted low-cost fossil fuels
- A growing appreciation of the vulnerabilities associated with such patterns



A mostly renewable world more self reliant

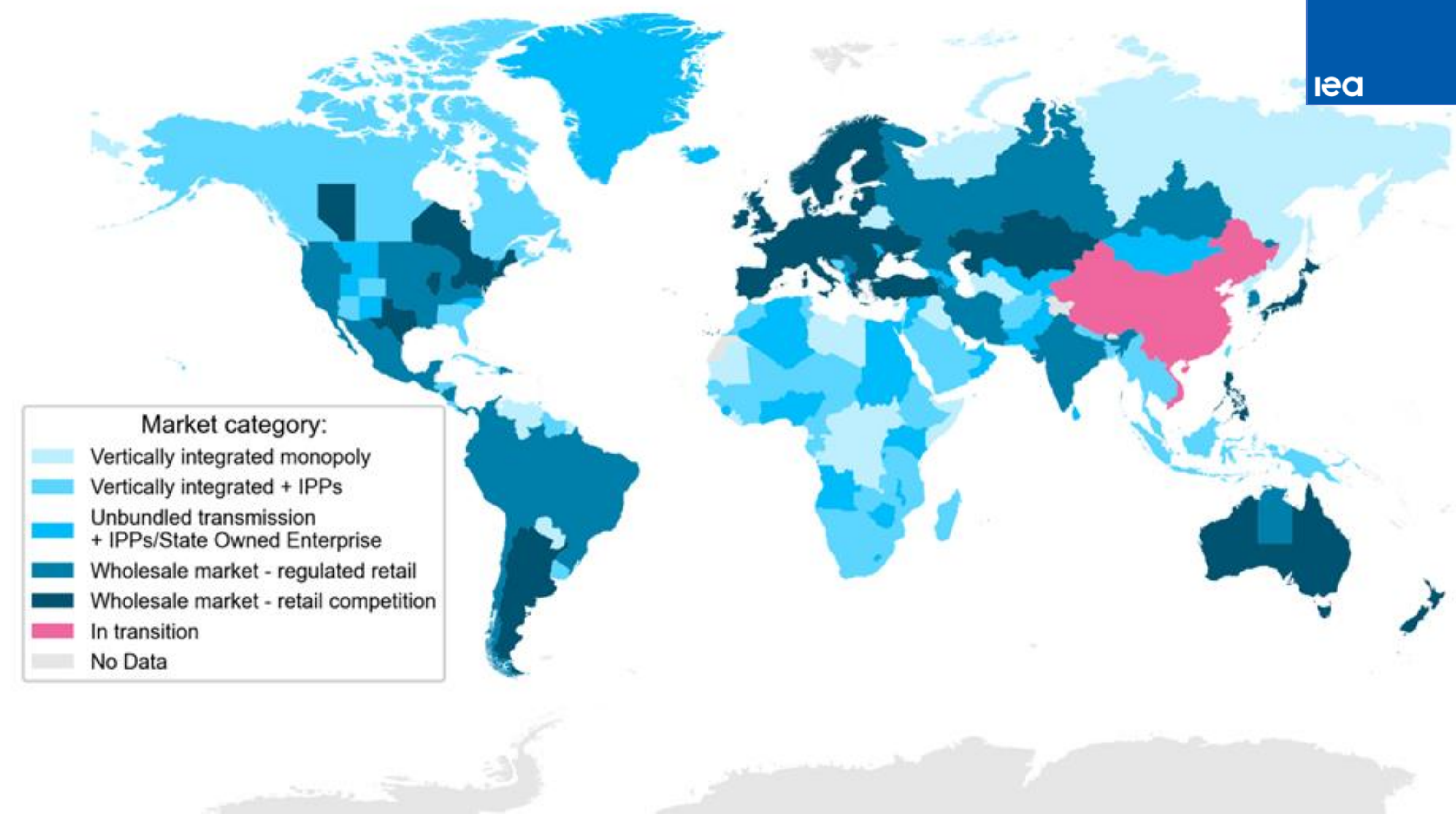
- **… however, various countries still seem likely to require energy imports** including Western Europe, Japan, Korea.
- What of the Pacific Island Countries and Territories?



Global class 7 on-shore wind and tracking PV potential by country (TWh/year)

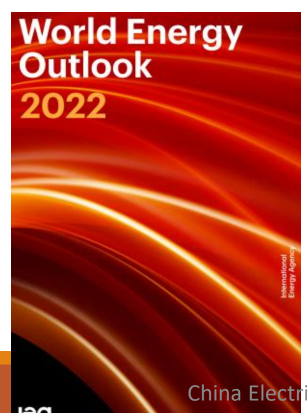
..also different industry decision-making arrangements

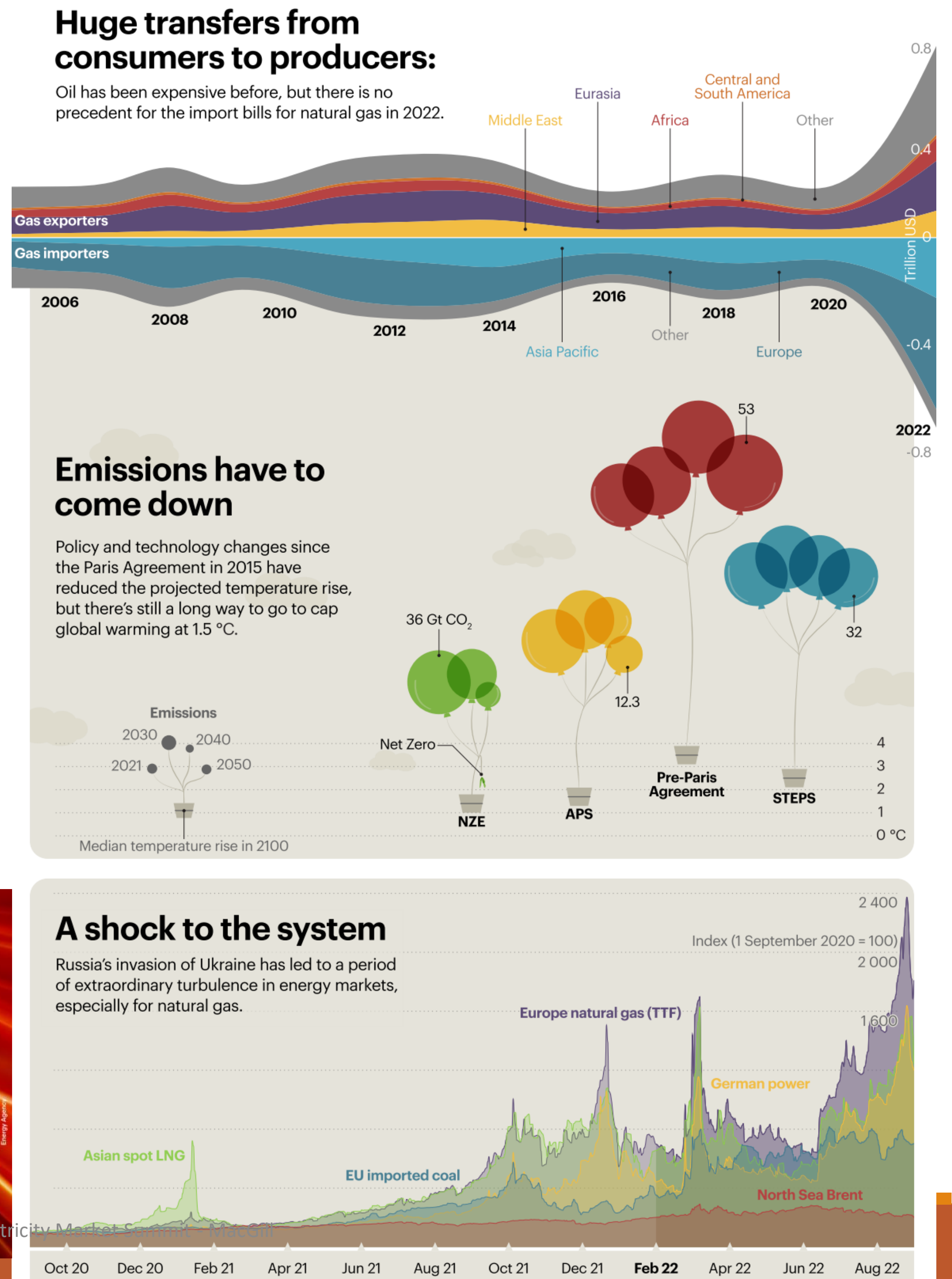
Status of electricity markets around the world in 2022



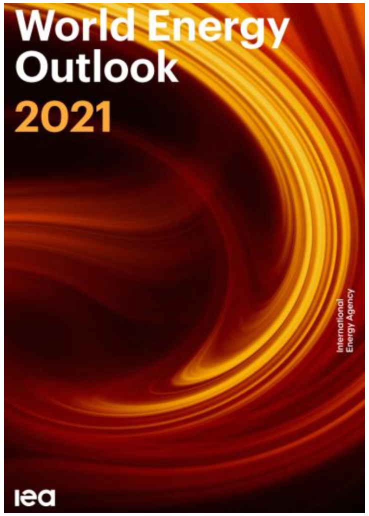
… and a global energy crisis to navigate

- Unprecedented gas + coal prices, high + volatile oil prices
- Growing climate change impacts, inadequate efforts to date avoid dangerous warming
- Enormous wealth transfers, adverse impacts on societal progress in developing + emerging economies, recession risks in industrialised nations





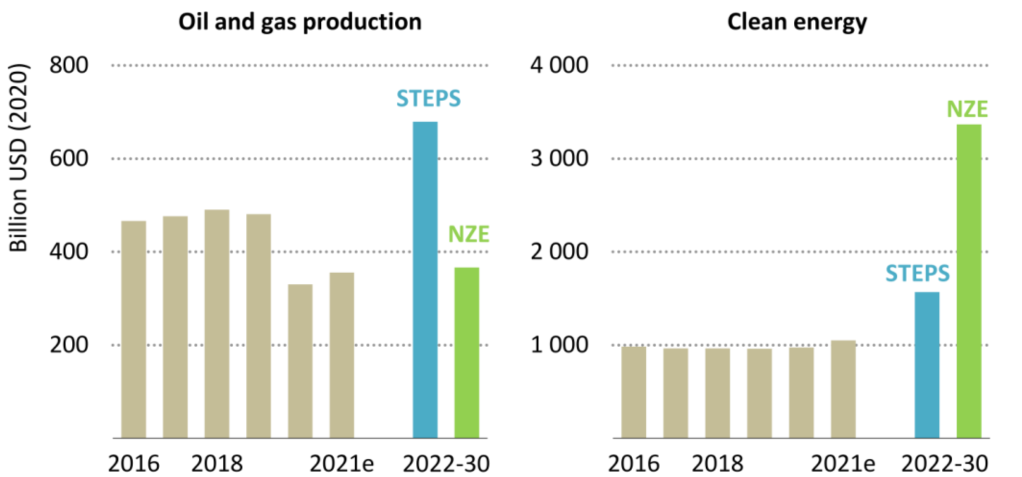
Energy transition to blame? Or lack of it?



At the time of publication of this year's *WEO*, governments are getting an advanced warning of this risk, with the prices of natural gas, coal and electricity rising to all-time highs in many regions. The key reasons for these sharp increases in energy prices are not related to efforts to transition to clean energy. They include a rapid economic rebound from last year's pandemic-induced recession, weather-related factors, and some planned and unplanned outages on the supply side.

As always with the energy sector, investment is critical. The IEA has been warning for years that current investment levels in the global energy sector are inadequate – both to meet near-term energy needs and long-term transition goals. It is hard to understate the dangers inherent in today's shortfall in spending on clean energy transitions, compared with the levels required. If we do not correct it soon, the risks of destabilising volatility will only grow as we move forward.

Figure 1.22 ▷ Investment in oil and gas production and clean energy in the Stated Policies and Net Zero Emissions by 2050 scenarios



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Currently, investment in oil and gas production is closer to the NZE than the STEPS, even while today's spending on clean energy is well below levels reached in both scenarios

*Hence our challenge, globally and locally, is to drive **lots** of energy and related investment, **quickly** and **wisely***

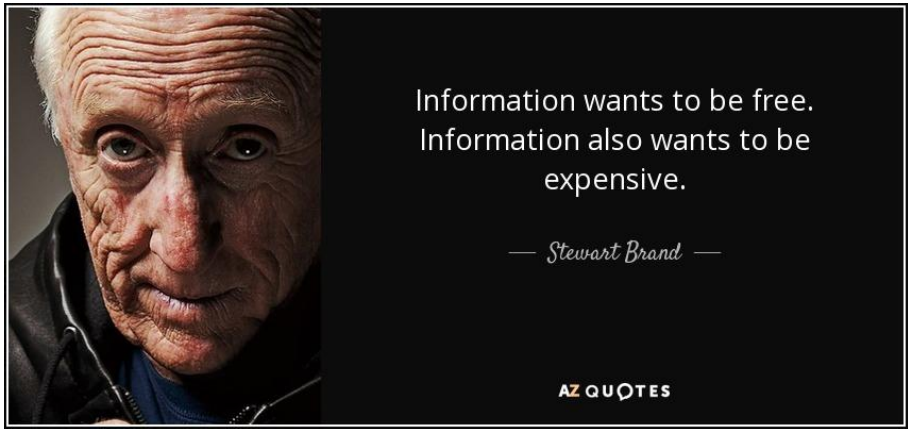
Decision making

- A **decision** is the commitment to irrevocably allocate valuable resources *with consequences*. *Hand waving doesn't count*
- Decision-making framework
  - What objectives? – *lots of them in energy*
  - What decisions *(available choices) – almost every decision an energy decision*
  - How are they taken *(process) – can you get good decisions with bad processes?*
- Good decision making more likely with
  - Clear and agreed objectives – *complementary great, but what if competing?*
  - Clarity on actually available options – 'real world' data, knowledge
  - Well informed decision makers – *lots of decision makers in energy transition*
  - With a good process that includes all stakeholders – *everyone is a stakeholder*
  - Autonomy for the decision maker (decision theirs to make) … but also accountability
- Good governance – *the process whereby societies or organisations make important decisions, determine whom they involve and how they render account*
- *Data and tools don't make decisions, instead decision support*

Data isn't free.. but can be 'low cost' + 'high value'

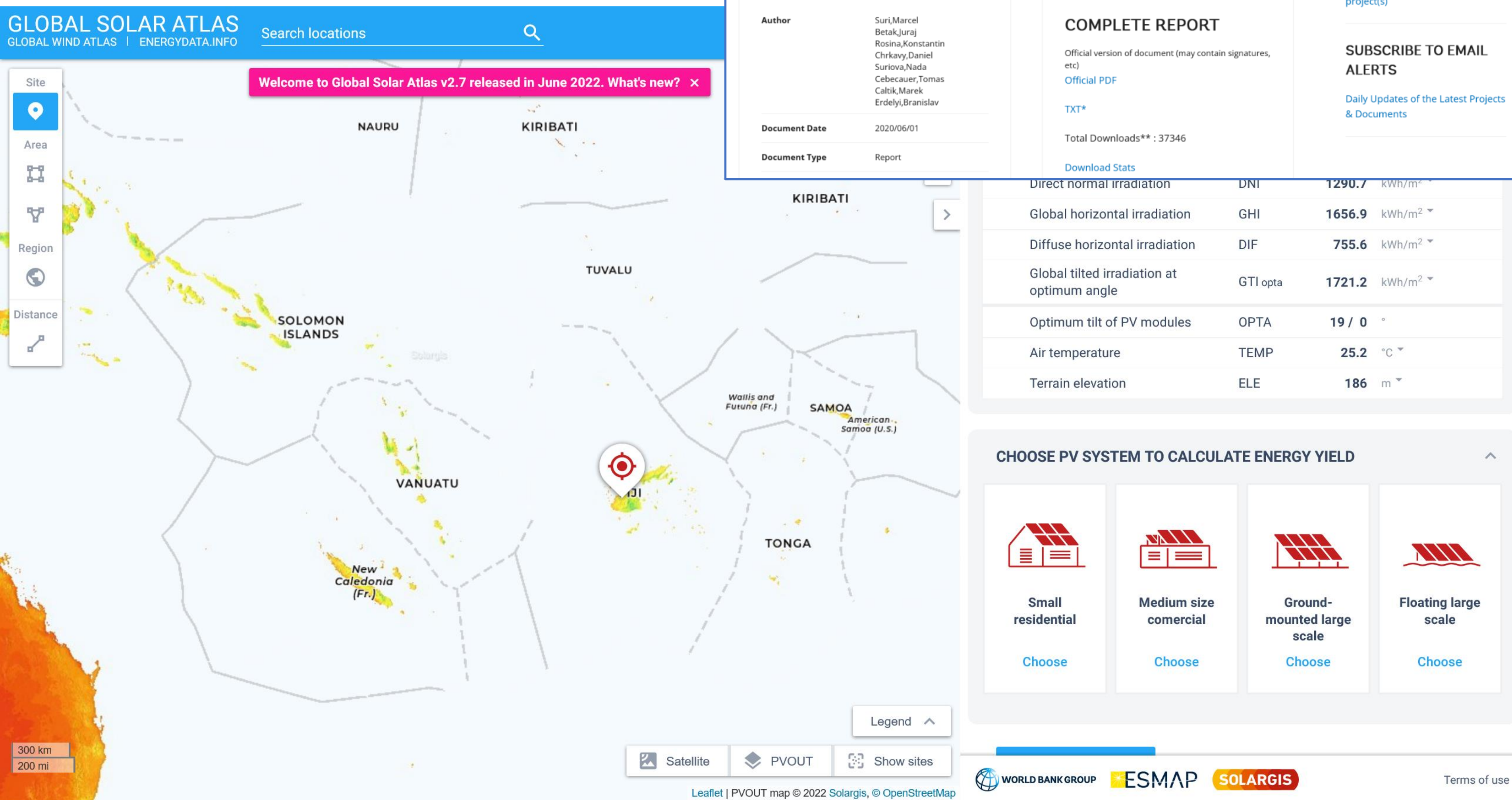
information wants to be expensive*, because it's so valuable. The right information in the right place just changes your life.*

On the other hand, ***information wants to be free****, because the cost of getting it out is getting lower and lower all the time.* Stuart Brand

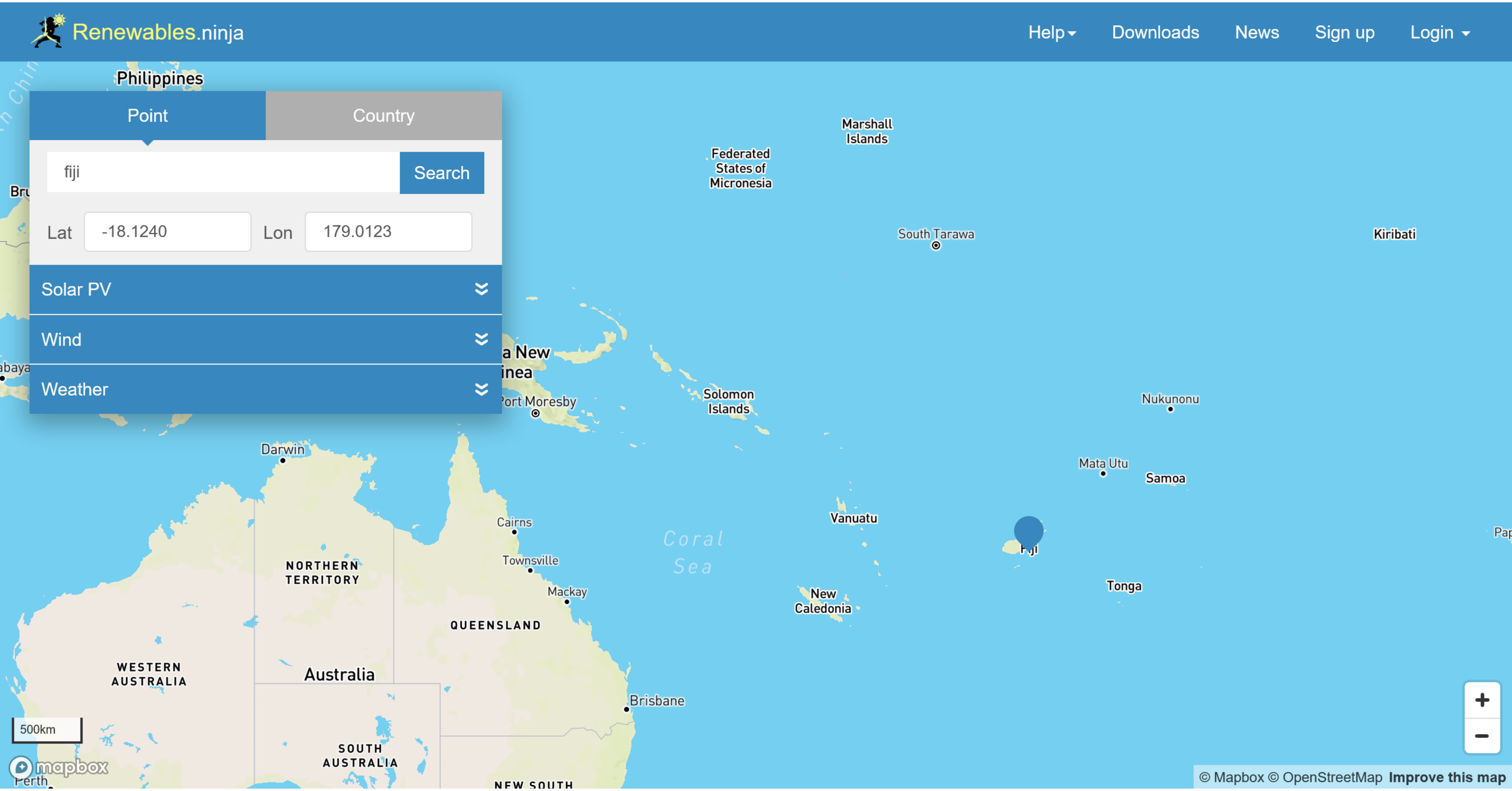


- Open-source data tools
  - Make it available
  - Make it pretty
  - *Make it actionable*

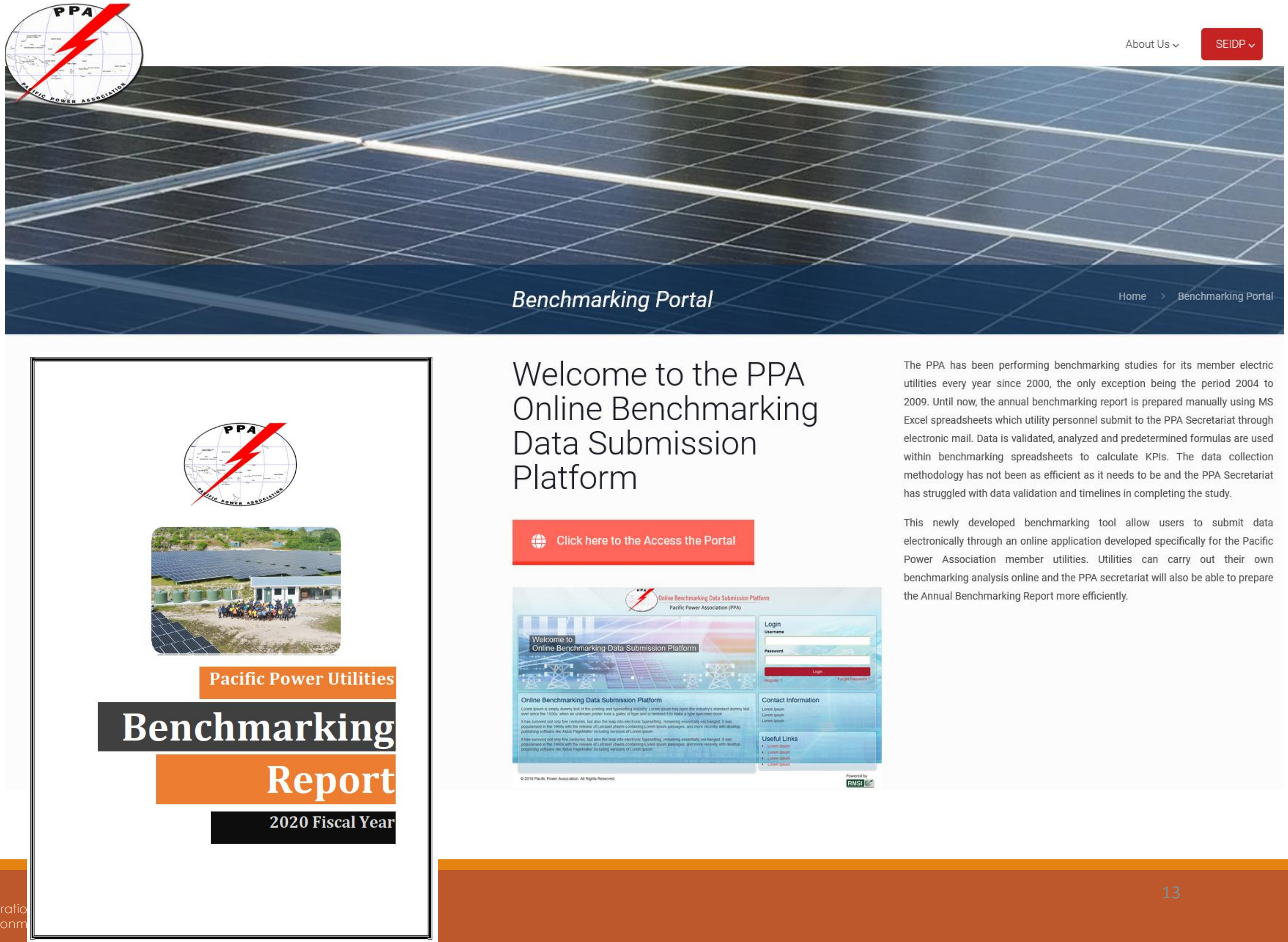
Valuable open-data resources and tools increasingly available



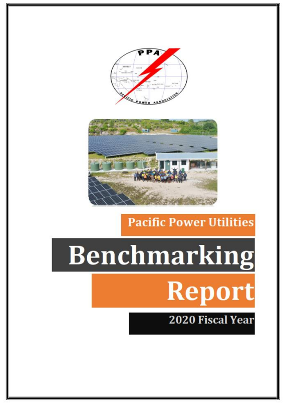
… including completely open-source efforts



Key regional data and insight efforts



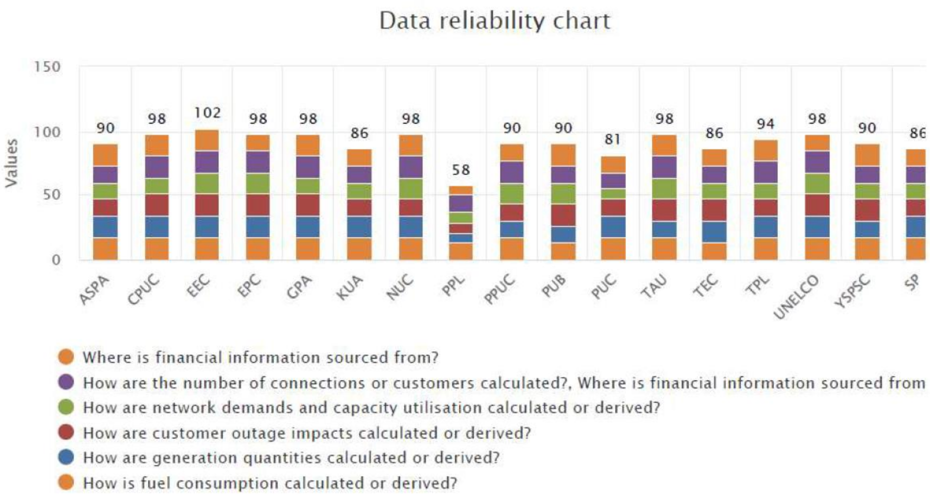
As always, more to be done

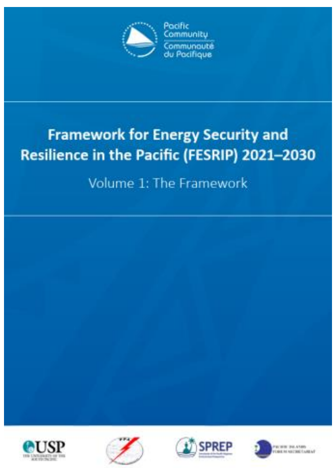


4. Data Reliability

Figure 4.2 aggregates the reliability scores submitted by each of the utilities in order to rank the relative reliability of the data that was submitted. These aggregate scores have furthermore been utilised as a weighting in this reporting in calculating the Composite Indicator for the 2020 FY.

Figure 4.2: Data Reliability Chart

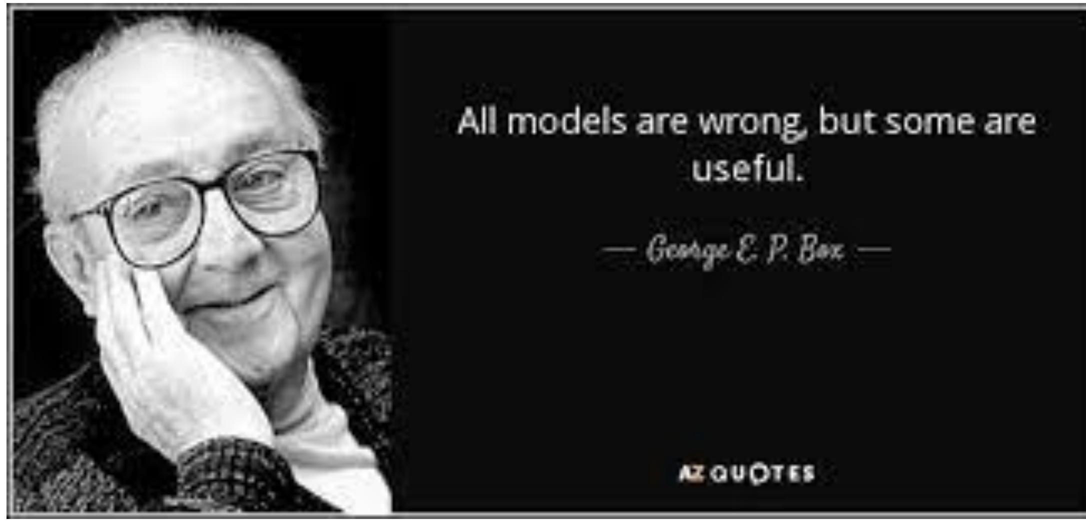




Inadequate data and energy security indicators. In recent years, there has been some improvement in the collection of energy data, which are generally good for the power sector (the main grid supply of national or state utilities), reasonably good for a limited number of (mostly urban) household energy surveys, poor for transport and miscellaneous fuel use, and poor for rural energy use in general, whether off-grid power or biomass for cooking. Data for energy security indicators need to be improved. The relevant CROP agencies (SPC, PPA, SPREP and USP) need, and are seeking, substantial ongoing support for data collection, analysis and sharing, which are required for effective decision making and monitoring of progress.

Energy modelling tools

Energy system models are crucial to plan energy transition pathways and understand their impacts. A vast range of energy system modelling tools is available, providing modelling practitioners, planners, and decision-makers with multiple alternatives to represent the energy system according to different technical and methodological considerations.



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Trends in tools and approaches for modelling the energy transition

Miguel Chang[a,*], Jakob Zink Thellufsen[a], Behnam Zakeri[b,c], Bryn Pickering[d], Stefan Pfenninger[d], Henrik Lund[a], Poul Alberg Østergaard[a]

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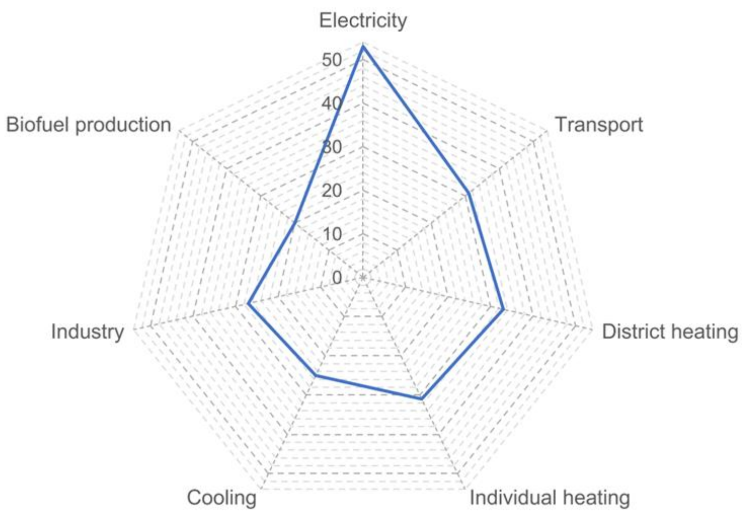
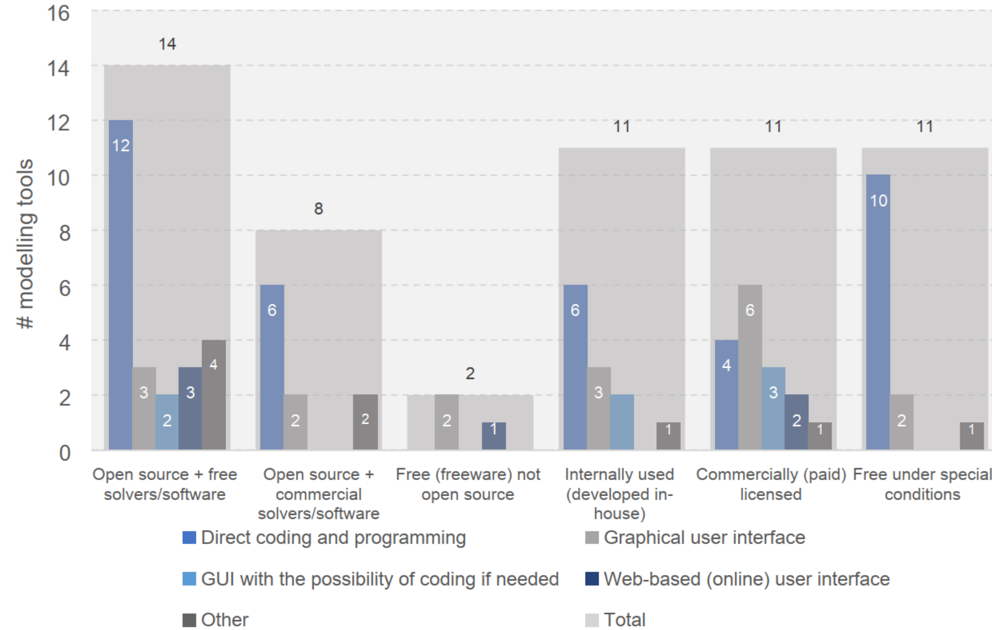
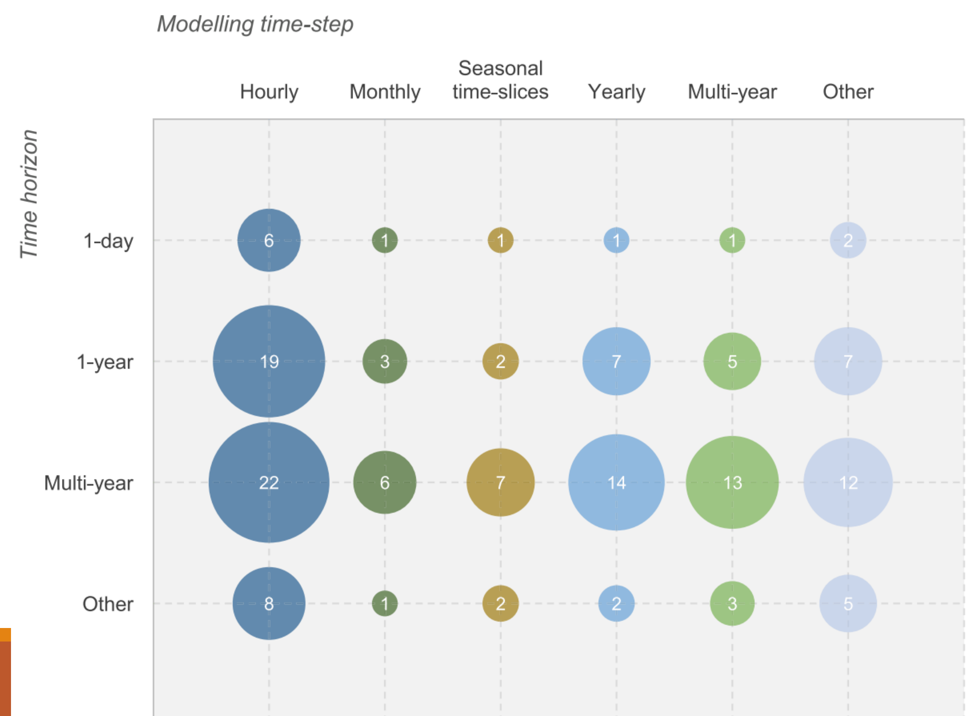
HIGHLIGHTS

- Survey of current trends and challenges in energy system modelling tools (N = 54).
- Tool features, linkages, user accessibility and policy application were reviewed.
- Growing coverage of cross-sectoral synergies, open access, and improved temporal detail.
- Challenges in representing high resolution energy demand in all sectors.
- Key issues remain in understanding tool coupling, accessibility & perceived policy-relevance.

Many, and growing number of potentially relevant energy modelling tools







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Open data, tools and processes

- Transparency versus 'black boxes' – supporting verification, impact of assumptions, sensitivity analysis
- Wider stakeholder engagement by reducing costs for participation
- Opportunity to explore wider scenarios

Energy scientists must show their workings

Public trust demands greater openness from those whose research is used to set policy, argues **Stefan Pfenninger**.

The global transition towards a clean and sustainable energy future is well under way. New figures from Europe this month show that the continent is on track to reach its goal of a 20% renewable-energy share by 2020, and renewable capacity in China and the United States is also rising. But many technical, political and economic uncertainties remain, not least in the data and models used to underpin such policies. These uncertainties need open discussion, and yet energy strategies all over the world are based on research not open to scrutiny.

Researchers who seek, for example, to study the economic and energy model used by the US government (called NEMS) are met with a forbidding warning. On its website, the Energy Information Administration, which is developing the model, pronounces: "Most people who have requested NEMS in the past have found out that it was too difficult or rigid to use."

At least NEMS (National Energy Modelling System) is publicly available. Most assumptions, systems, models and data used to set energy policy are not. These black-box simulations cannot be verified, discussed or challenged. This is bad for science, bad for the public and spreads distrust. Energy research needs to catch up with the open-software and open-data movements. We energy researchers should make our computer programs and data freely accessible, and academic publishing should shun us until we do.

BLACK-BOX SIMULATIONS CANNOT BE VERIFIED, DISCUSSED OR CHALLENGED.

Our community's models are relevant to policy because they explore alternative scenarios or seek to understand the technical constraints on deploying new energy technologies. It is modelling for insight (by an academic exploring a range of qualitatively different scenarios for a clean energy supply, say) and for numbers (as in a government agency deciding on the remuneration level of a technology-support scheme).

Trust in this research matters because it contributes to policies on energy — and, by extension, on climate mitigation — that produce winners and losers throughout the global economy, and so can be hotly contested. Such policies are among the crucial driving forces that led to the current surge in the development of wind and solar power.

The list of reasons why energy models and data are not openly available is long: business confidentiality; concerns over the security of critical infrastructure; a desire to avoid exposure and scrutiny; worries about data being misrepresented or taken out of context; and a lack of time and resources.

This secrecy is problematic, because it is well known that closed systems hide and perpetuate mistakes. A classic example is the spreadsheet error discovered in the influential Reinhart–Rogoff paper used to support economic policies of national austerity. The European Commission's Energy Roadmap 2050 was based on a model that could not be viewed by outsiders, leaving it open to criticism. Assumptions that remain hidden, like the costs of technologies, can largely determine what comes out of such models. In the United Kingdom, opaque and overly optimistic cost assumptions for onshore wind went into models used for policymaking, and that may well have delayed the country's decarbonization.

This closed culture is alien to younger researchers, who grew up with collaborative online tools and share code and data on platforms such as GitHub. Yet academia's love affair with metrics and the pressure to publish set the wrong incentives: every hour spent on cleaning up a data set for public release or writing open-source code is time not spent working on a peer-reviewed paper.

Nevertheless, some academic-led projects are pushing towards more openness. The Enipedia project is building a worldwide open database on power plants, with data such as their locations and emissions. The Open Power System Data project gathers data such as electricity consumption from government agencies and transmission-network operators, and pushes for clarity on the licensing under which these data are made available. The Open Energy Modelling Initiative is emerging as a platform for coordinating and strengthening such efforts.

Regulation can also help. The European Union has mandated open access to electricity-market data, resulting in the creation of the ENTSO-E Transparency Platform to hold it, and there are good arguments for the creation of national energy-data agencies to coordinate the collection and archiving of a range of important data.

The vast majority of published research is still untouched by these fledgling initiatives. Only one energy journal — *Energy Economics* — currently requires data and models alongside submissions. Other journals should follow suit.

The open sharing of code and data is also important because it permits more meaningful collaboration between academics. Sharing a DNA sequence in an established format is, of course, easier than sharing the unstructured assumptions behind a techno-economic scenario study, for which no standard format exists yet. So the energy community must decide on standards for sharing code, data and assumptions.

A change in journal policies would help to kick-start these discussions. In policy-focused research, where one 'truth' does not exist, one cannot assess whether a modelled scenario is 'correct', so the important yardstick is not truth, but trust. The arrival of the post-truth world shows that trust in experts is lower than ever — and surely this is partly the experts' fault. ■

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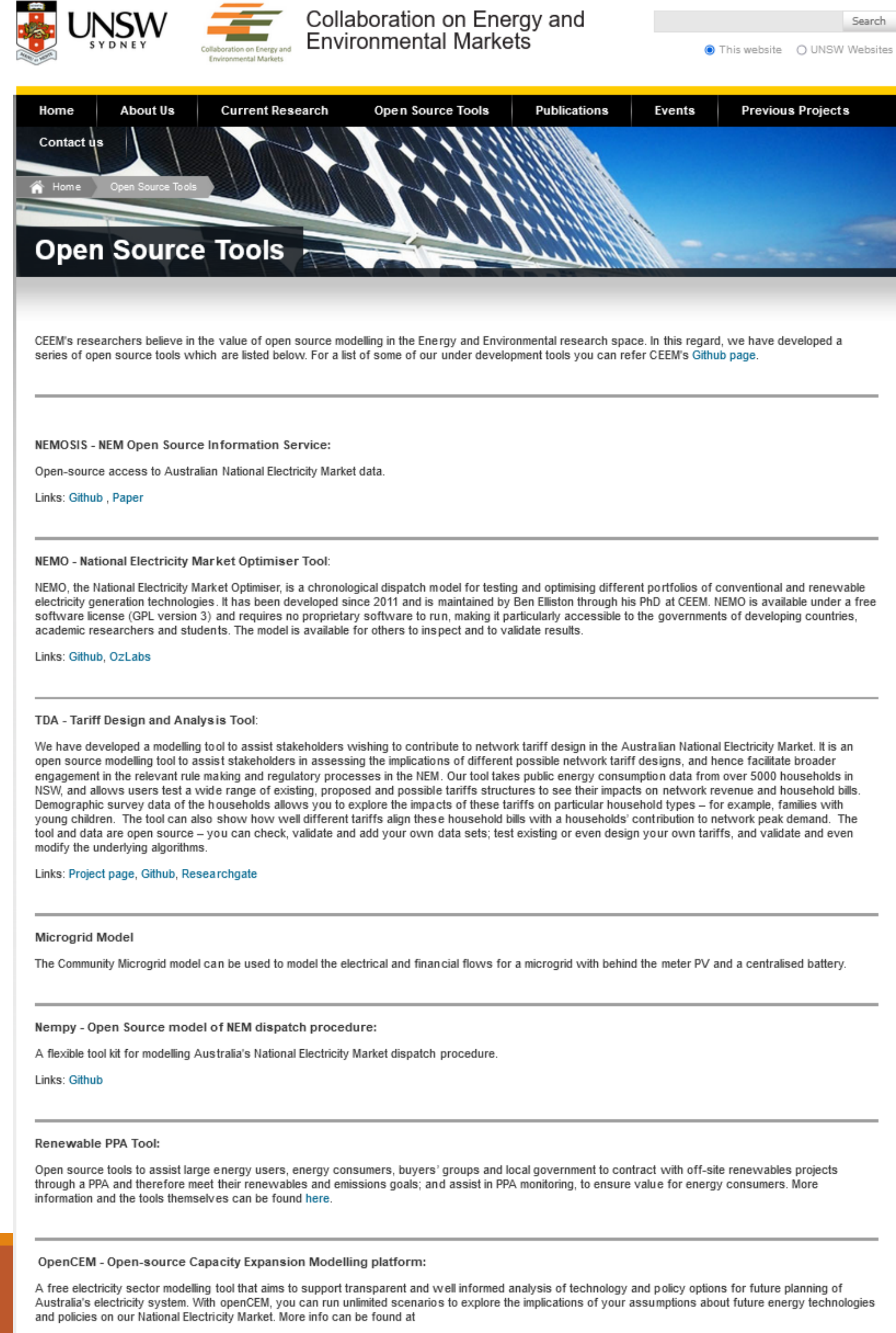

Open Source Tools

CEEM's researchers believe in the value of open source modelling in the Energy and Environmental research space. In this regard, we have developed a series of open source tools which are listed below. For a list of some of our under development tools you can refer CEEM's Github page.

NEMOSIS - NEM Open Source Information Service:

Open-source access to Australian National Electricity Market data.

Links: Github , Paper

NEMO - National Electricity Market Optimiser Tool:

NEMO, the National Electricity Market Optimiser, is a chronological dispatch model for testing and optimising different portfolios of conventional and renewable electricity generation technologies. It has been developed since 2011 and is maintained by Ben Elliston through his PhD at CEEM. NEMO is available under a free software license (GPL version 3) and requires no proprietary software to run, making it particularly accessible to the governments of developing countries, academic researchers and students. The model is available for others to inspect and to validate results.

Links: Github, OzLabs

TDA - Tariff Design and Analysis Tool:

We have developed a modelling tool to assist stakeholders wishing to contribute to network tariff design in the Australian National Electricity Market. It is an open source modelling tool to assist stakeholders in assessing the implications of different possible network tariff designs, and hence facilitate broader engagement in the relevant rule making and regulatory processes in the NEM. Our tool takes public energy consumption data from over 5000 households in NSW, and allows users test a wide range of existing, proposed and possible tariffs structures to see their impacts on network revenue and household bills. Demographic survey data of the households allows you to explore the impacts of these tariffs on particular household types – for example, families with young children. The tool can also show how well different tariffs align these household bills with a households' contribution to network peak demand. The tool and data are open source – you can check, validate and add your own data sets; test existing or even design your own tariffs, and validate and even modify the underlying algorithms.

Links: Project page, Github, Researchgate

Microgrid Model

The Community Microgrid model can be used to model the electrical and financial flows for a microgrid with behind the meter PV and a centralised battery.

Nempy - Open Source model of NEM dispatch procedure:

A flexible tool kit for modelling Australia's National Electricity Market dispatch procedure.

Links: Github

Renewable PPA Tool:

Open source tools to assist large energy users, energy consumers, buyers' groups and local government to contract with off-site renewables projects through a PPA and therefore meet their renewables and emissions goals; and assist in PPA monitoring, to ensure value for energy consumers. More information and the tools themselves can be found here.

OpenCEM - Open-source Capacity Expansion Modelling platform:

A free electricity sector modelling tool that aims to support transparent and well informed analysis of technology and policy options for future planning of Australia's electricity system. With openCEM, you can run unlimited scenarios to explore the implications of your assumptions about future energy technologies and policies on our National Electricity Market. More info can be found at

Serious open-source efforts, still some questions

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Software

See the table below for our open-source software offerings.

For the most current listing of NREL-developed open-source software, see U.S. Department of Energy Office of Scientific and Technical Information's DOE CODE database.

Commercial Licensing

Explore more than 200 copyrighted software tools available for licensing via the Department of Energy's Lab Partnering Service.

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Are open source energy system optimization tools mature enough for serious use?

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ARTICLE INFO

Keywords:
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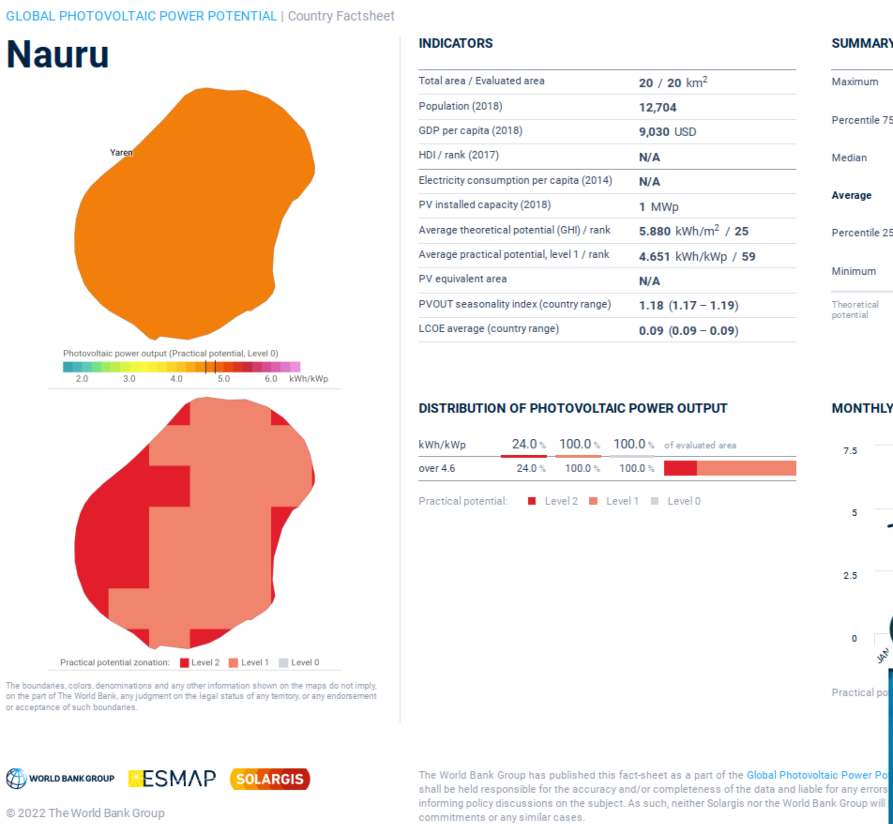
Multi-energy system
Sector coupling
Optimization
Simulation

ABSTRACT

Historically, energy system tools were predominantly proprietary and not shared with others. In recent years, there has been an increase in developing open source tools by international research and development organizations. More than half of the open energy modeling (openmod) initiative listed tools are based on the freely available scripting language Python. Previous comparisons of energy and power system modeling tools focused on comparisons such as which tool category (e.g. optimization, simulation) or energy demand (e.g. electricity, cooling, and heating) can be considered. Until now, the assessment of incorporated functions such as unit commitment (UC) or optimum power flow (OPF) has been ignored. Therefore, this work assesses 31 mostly open source tools based on 81 functions for their maturity. The result shows that available open source tools such as Switch, TEMOA, OSeMOSYS, and pyPSA are mature enough based on a function comparison with commercial or proprietary tools for serious use. Nevertheless, future commercial, as well as open source energy system analysis tools, have to consider more functions such as the impact of ambient air conditions and part-load behavior to allow better assessments of including high shares or renewable energy sources and other flexibility measures in existing and new energy systems.

Jurisdictional renewable energy potential assessments



GLOBAL PHOTOVOLTAIC POWER POTENTIAL | Country Factsheet

Page 1 of 3

Nauru

Yaren

Photovoltaic power output (Practical potential, Level 0)

2.0 3.0 4.0 5.0 6.0 kWh/kWp

Practical potential zonation: Level 2 Level 1 Level 0

The boundaries, colors, denominations and any other information shown on the maps do not imply, on the part of The World Bank, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.

INDICATORS

Total area / Evaluated area	20 / 20 km^2
Population (2018)	12,704
GDP per capita (2018)	9,030 USD
HDI / rank (2017)	N/A
Electricity consumption per capita (2014)	N/A
PV installed capacity (2018)	1 MWp
Average theoretical potential (GHI) / rank	5.880 kWh/m^2 / 25
Average practical potential, level 1 / rank	4.651 kWh/kWp / 59
PV equivalent area	N/A
PVOUT seasonality index (country range)	1.18 (1.17 – 1.19)
LCOE average (country range)	0.09 (0.09 – 0.09)

SUMMARY STATISTICS

Theoretical potential (kWh/m^2, GHI)		Practical potential, Level 1 (kWh/kWp, PVOUT)	
Maximum	5.89	Maximum	4.66
Percentile 75	5.88	Percentile 75	4.65
Median	5.88	**Average**	4.65
Average	5.88	Median	4.65
Percentile 25	5.88	Percentile 25	4.65
Minimum	5.87	Minimum	4.64

DISTRIBUTION OF PHOTOVOLTAIC POWER OUTPUT

kWh/kWp	24.0 %	100.0 %	100.0 % of evaluated area
over 4.6	24.0 %	100.0 %	100.0 %

Practical potential: Level 2 Level 1 Level 0

MONTHLY VARIATION OF PHOTOVOLTAIC POWER OUTPUT

7.5 5 2.5 0

Jan

Practical po

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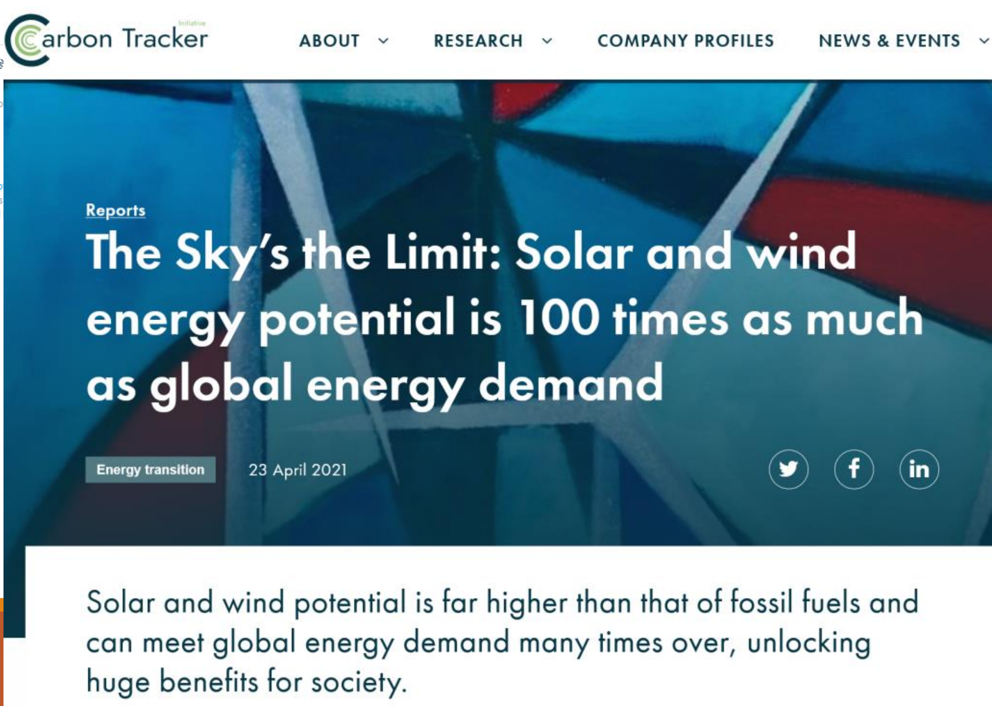


Some UNSW work underway

(with Shayan Naderi, Edoardo Santagata, Anna Bruce)

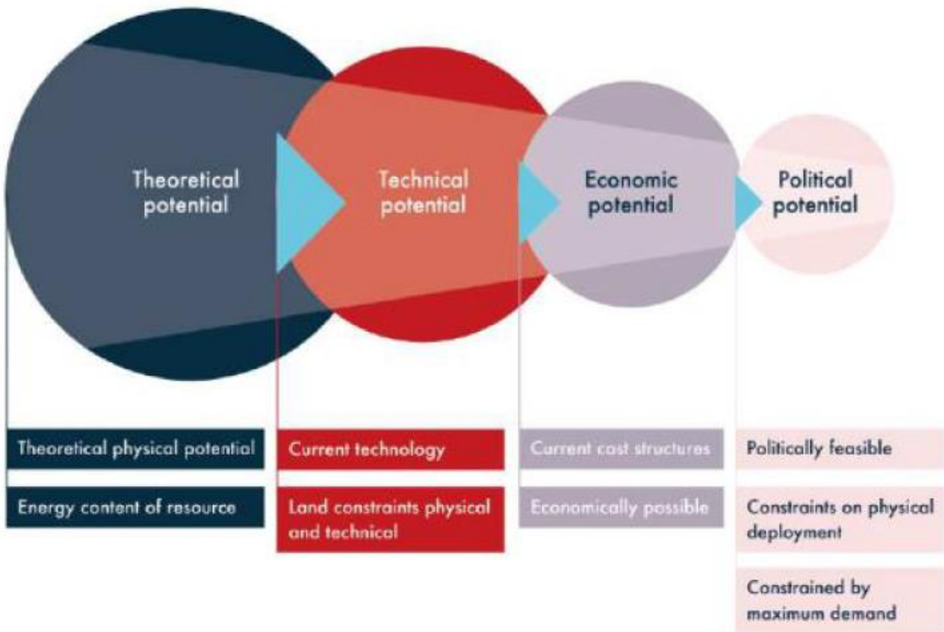
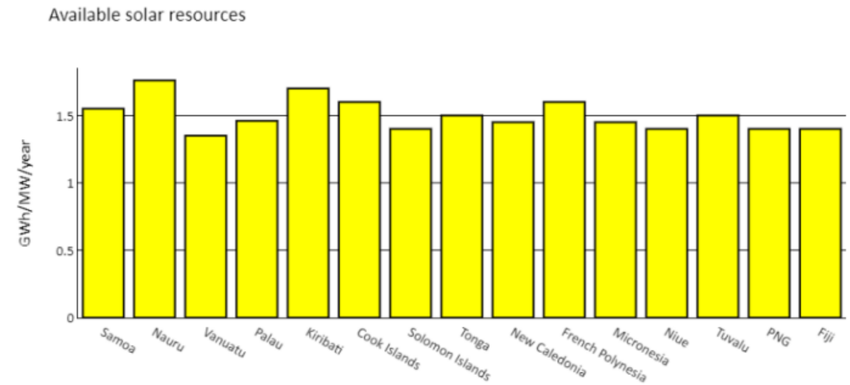
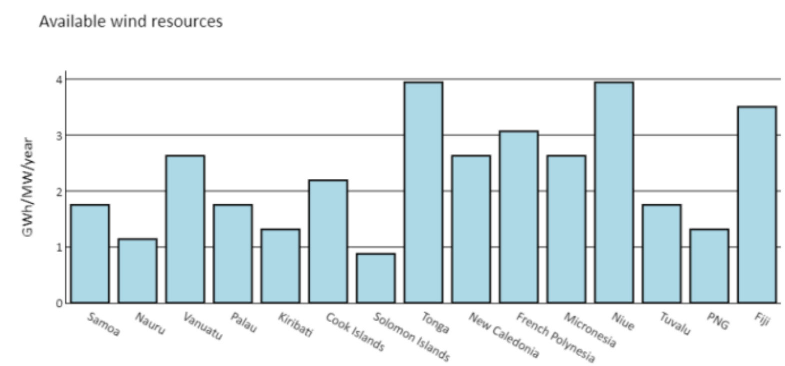
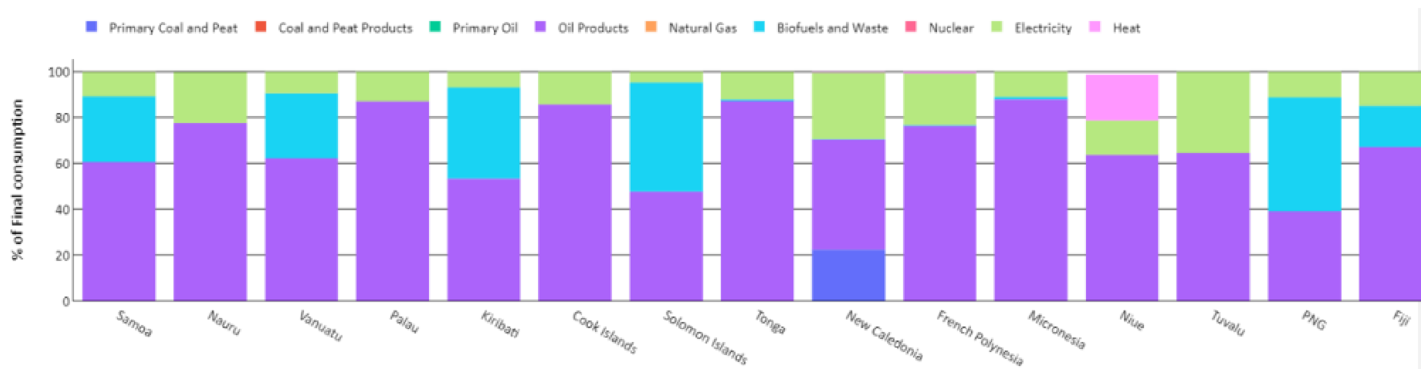


Figure 31: Renewable Energy Potential framework (CTI, 2021)





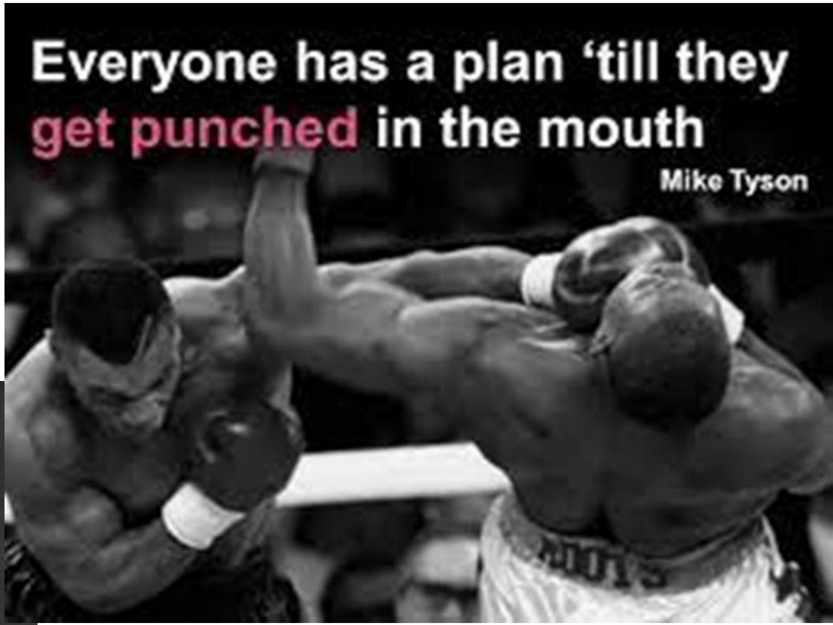


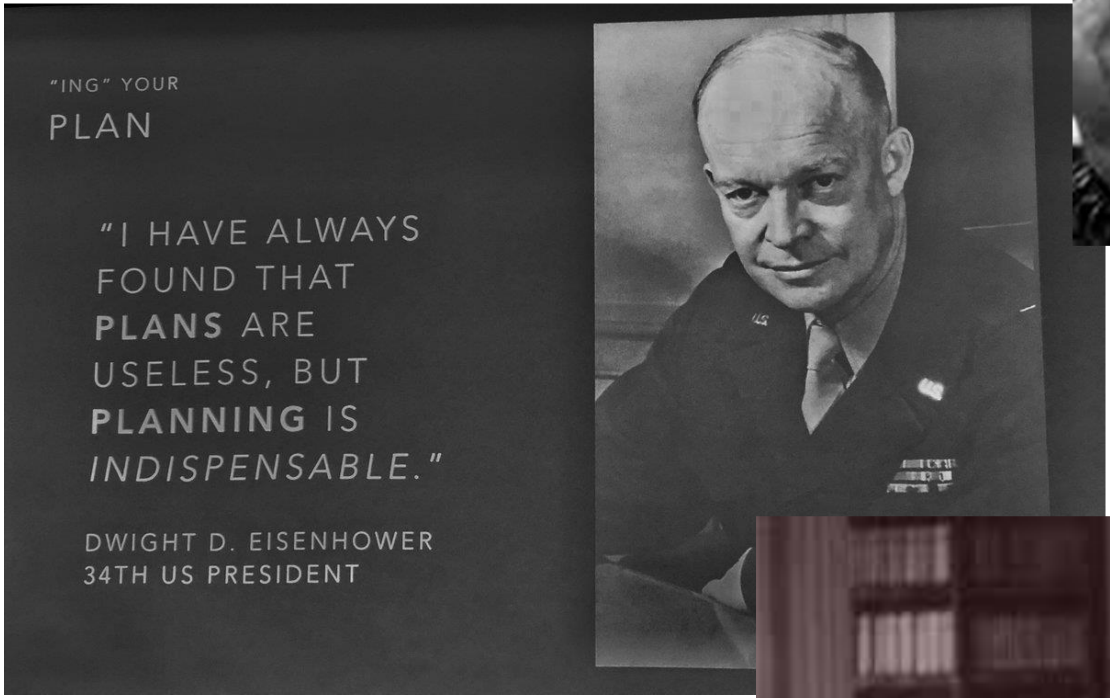
Choose your assumptions

- Technical – e.g. available land use, future levels of demand, electrification
- Economic – e.g. renewables (and firming) costs, costs of alternatives

Country	Large-scale PV and wind technical potential (GWh/year)	Rooftop PV technical Potential (GWh/year)	Total PV technical potential (GWh/year)	Demand for decarbonizing the electricity sector (GWh/year)	Final demand of electrification scenario (GWh/year)	Final demand based on net zero emission scenario (GWh/year)
Samoa	1,147	51	1,198	94	605	2,025
Nauru*	16	2	18	36	102	107
Vanuatu	4,505	64	4,569	61	356	3,078
Palau	1,347	8	1,355	94	422	179
Kiribati	776	23	799	26	145	1,190
Cook Islands	152	3	155	29	167	175
Solomon Islands	2,861	137	2,998	95	635	6,529
Tonga	1,271	24	1,295	64	337	1,007
New Caledonia	7,168	114	7,282	2,873	7,772	2,972
French Polynesia	4,323	86	4,409	492	1,818	2,759
Micronesia	7,804	18	7,822	64	282	1,045
Niue	165	1	166	4	12	16
Tuvalu	20	2	22	7	15	116
PNG	14,408	1,295	15,703	2,494	11,824	89,350
Fiji	9,513	230	9,743	449	3,009	9,293

Plans vs planning





The real executive summary of every energy plan?

Important notice

PURPOSE

AEMO has published the Integrated System Plan pursuant to its functions under section 49(2) of the National Electricity Law (which defines AEMO's function as National Transmission Planner) and section 5.20 of the National Electricity Rules and its broader functions to maintain and improve power system security.

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Possible insights for the region on energy planning

- We need planning, not plans
  - with all that means for funding programs not just projects, and building regional capacity for ongoing planning
  - Regional models but jurisdictional solutions – best practice models e.g. FRDP
- Where we are now?
  - Information for situational awareness – widest set of stakeholders, vulnerabilities and capabilities. This has to be ongoing
  - Current trajectories – no facts about the future but better and worse processes for exploring it in a useful way, growing range of tools for risk assessments, scenario analysis
- Where do want to go? Vision and goals
  - Energy access remains the key objective for many PICTs
  - Goals on how you do it (principles) as well as outcomes – *community oriented following subsidiarity (go as local as you can while consistent with resolution*
  - Integration with water, health, telecommunications and other key infrastructure goals
- How do we get there?
  - Inclusive planning processes – whole of government and beyond, private sector, community – integrated with other key infrastructure, emergency response planning
  - Integrated across supply and demand, grid vs mini-grid vs stand-alone solutions
  - Appropriate autonomy and accountability for decision makers
  - Strategy to initiatives to programs to projects
  - Ongoing review processes – for situation, goals and principles, actions

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Thank you all for all your work across the region

COP 27 ends on a high with loss and damage fund for vulnerable countries

Broadcast 8h ago

The COP 27 climate talks have come to an end in Egypt with an agreement on a new loss and damage facility for vulnerable countries. *(Supplied: UNFCCC)*

Share

The COP27 summit has ended with countries agreeing to a climate deal, including a loss and damage fund for vulnerable countries.

Fiji's Prime Minister Frank Bainimarama praised Pacific negotiators for their work at COP 27.

"Vinaka Vaka Levu from the bottom of my heart ...you have worked hardest to see climate justice delivered"