100% Clean Movement

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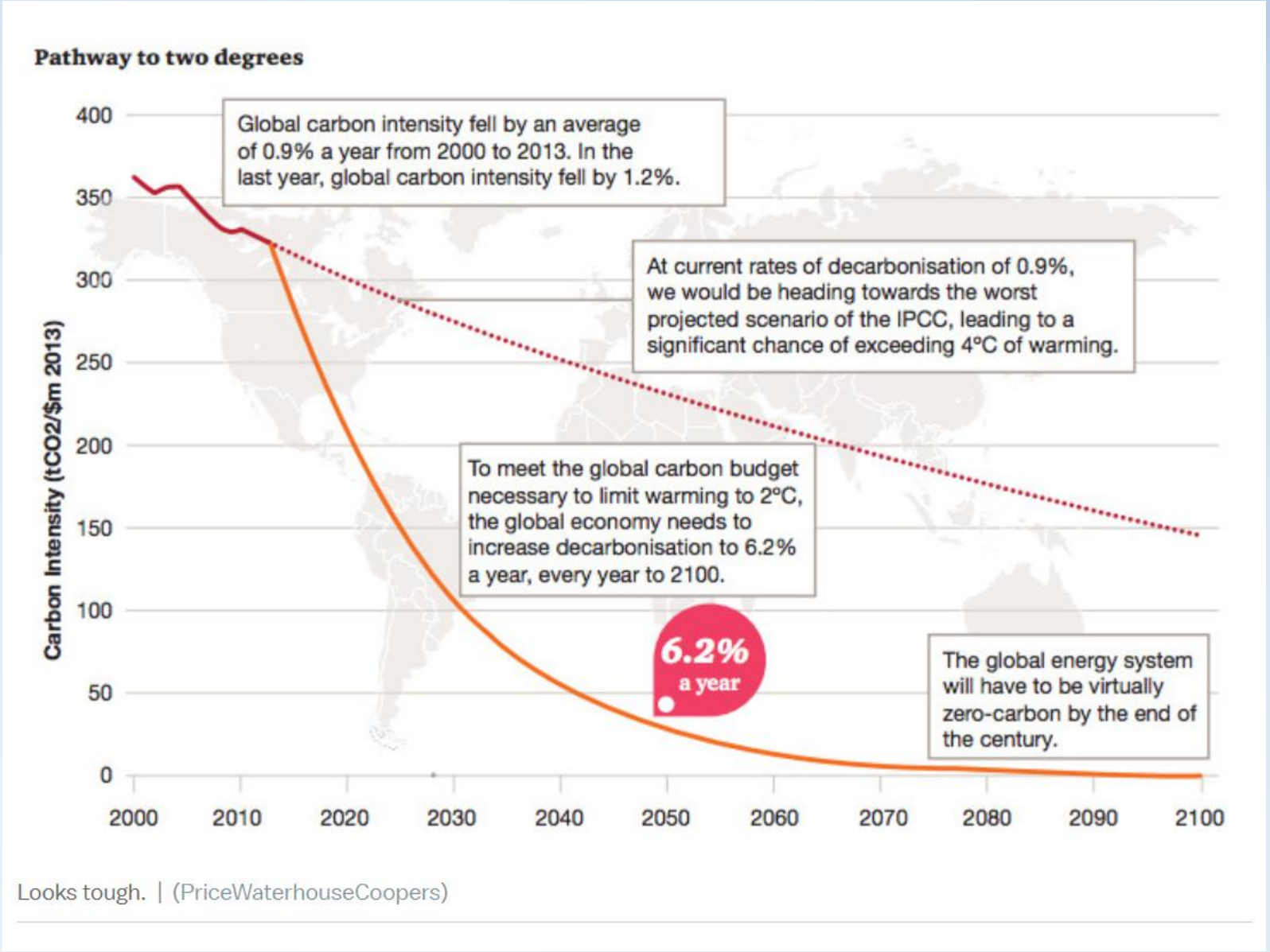
Clean Energy Transition

Agenda

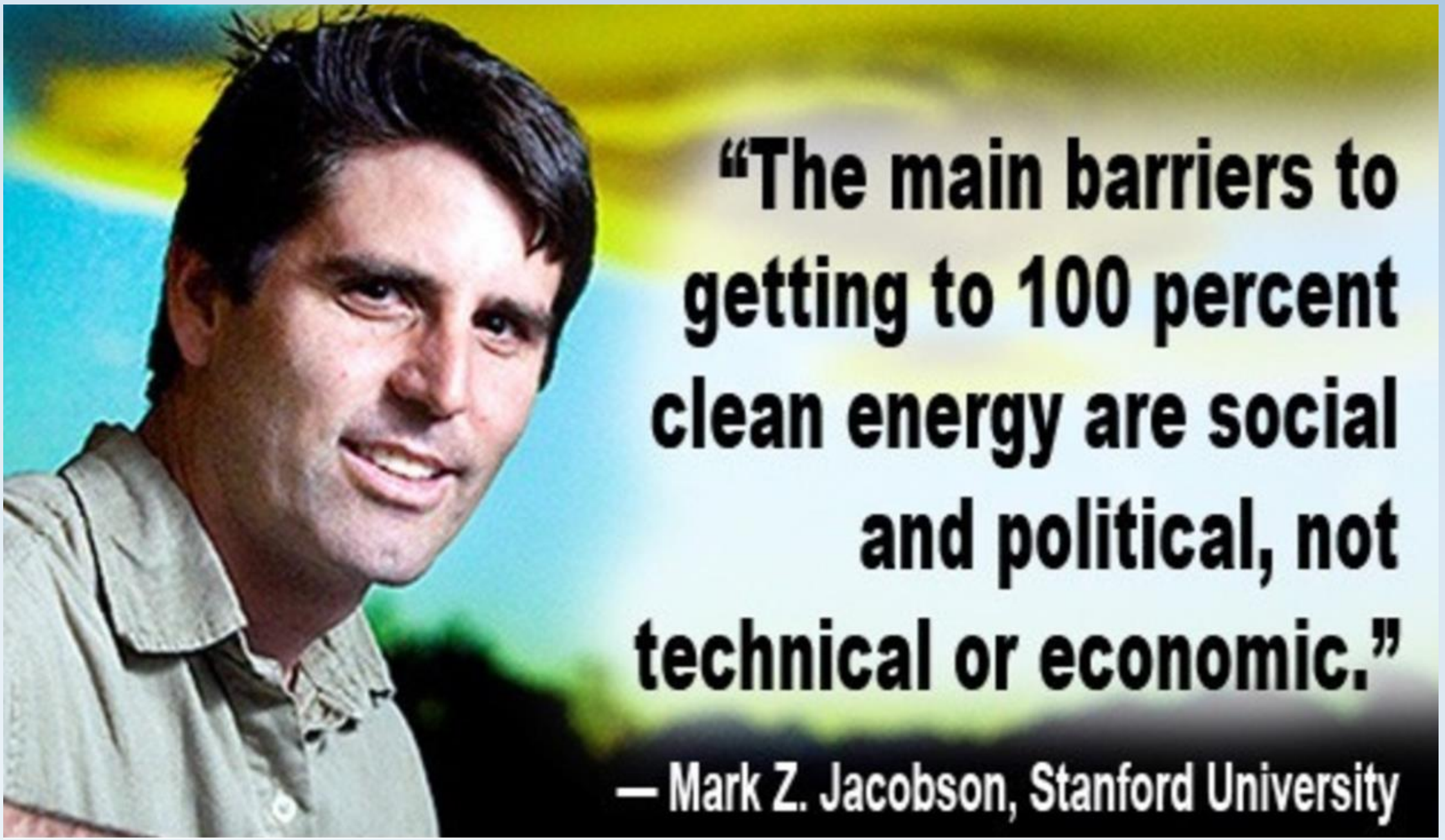
- 100% Renewable Concept
- 100% Renewable Controversy
- 100% Renewable Cities
- 100% Renewable Businesses
- Narrative if we have time

100% Renewable Concept

Pathways to 2 Degrees Celsius



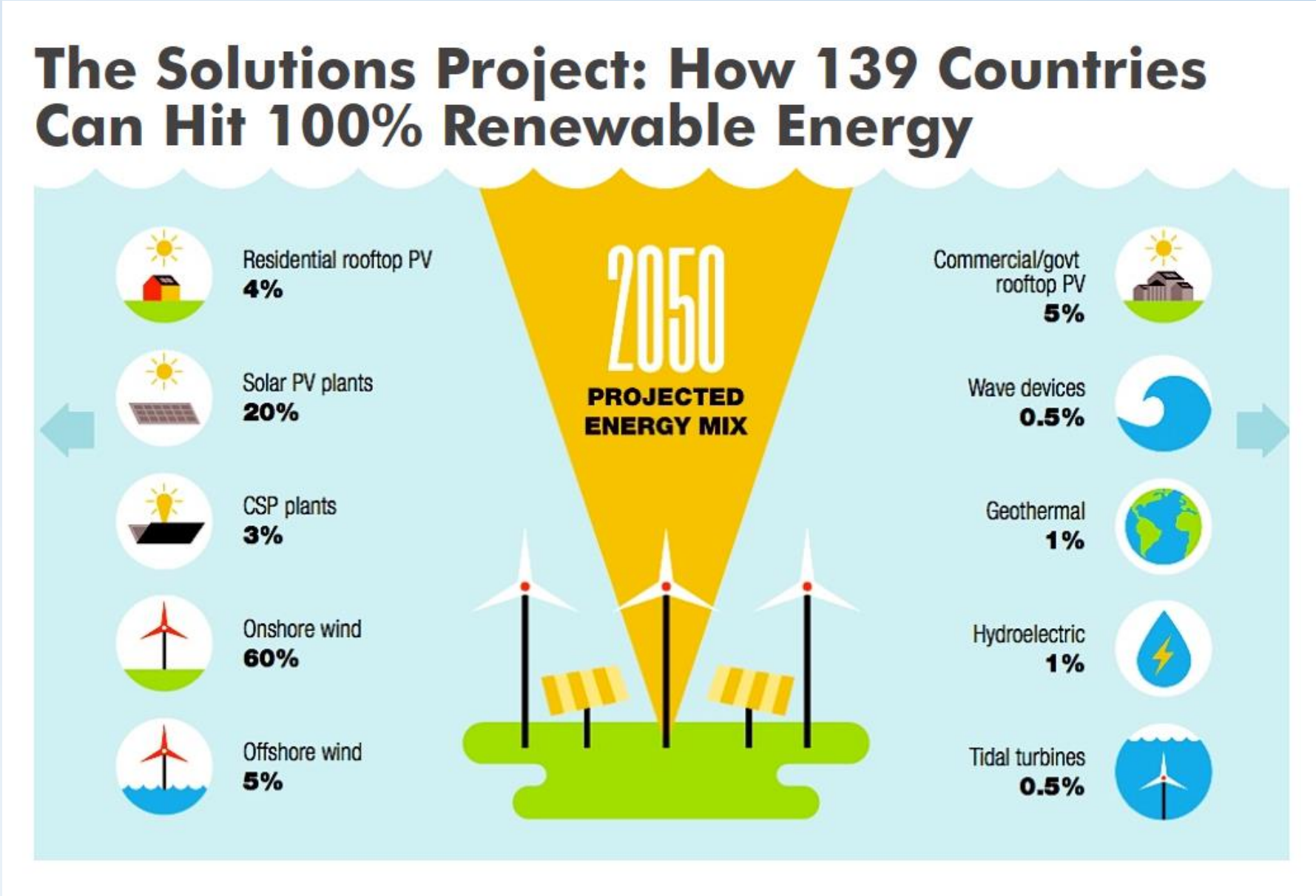
Looks tough. | (PriceWaterhouseCoopers)


“The main barriers to getting to 100 percent clean energy are social and political, not technical or economic.”
— Mark Z. Jacobson, Stanford University

The Solutions Project

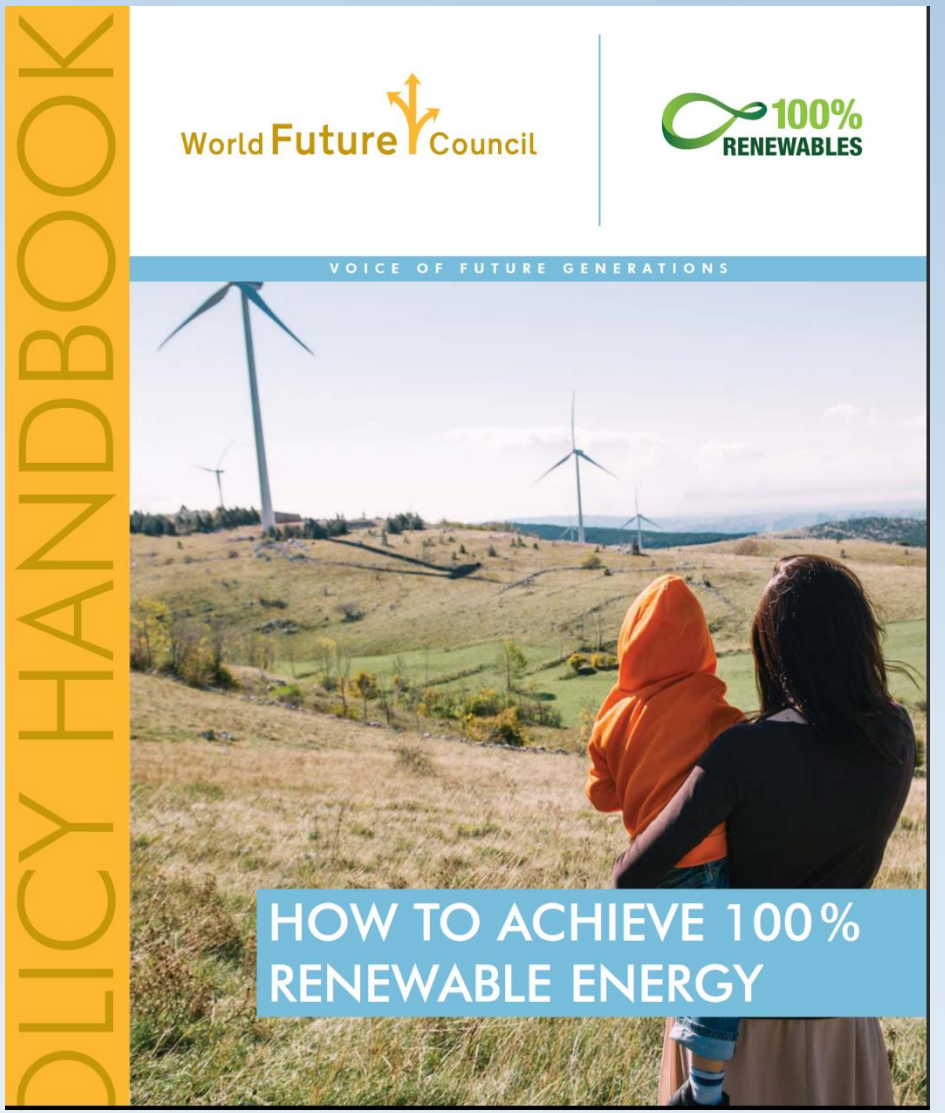
- 2011 paper—all global energy with wind, water, and solar power
- 2013 New York feasibility study—move entire state to renewables
- 2014 California roadmap 100% renewale
- 2015 50 roadmaps, one for every state & whole US on WWS

Solutions Project Goes Global



Emergence of 100% Renewable Energy

- 2014 Hamburg-based World Future Council "How to Achieve 100% Renewable Energy"
- Renewable Energy
  - ✓ Sun, wind, water (hydroelectricity), naturally occurring heat (geothermal), and plants
  - ✓ Completely doable with today's technology
- "[O]nly lack of political will that is preventing the world switching away from fossil fuels."



Technical Issues

- Issue is that RE is not dispatchable
- Variable renewable energy (VRE) Technical issues:
  - ✓ Curtailment when RE produces large spikes of power
  - ✓ Dips in VRE, daily, weekly, monthly, seasonally, and decadal.
  - ✓ Rapid ramping:
- VRE Economic Issues
  - ✓ Cost of integrating more VRE exceed the benefits

What Technical Issues Mean

- Massive overbuild of VRE
  - ✓ Its "capacity factor" (the amount of time it's running) is relatively low
  - ✓ To fully meet demand, total capacity will have to far exceed total demand, by multiples.
- Transmission lines be extended everywhere across the globe, to link VRE sources with demand and smooth out supply.
  - ✓ Distribution grids need to be upgraded fast
- Remaining dispatchable resources — demand management, storage, hydro, maybe biomass — "radically, radically scaled up.
  - ✓ Storage is going to have to grow exponentially.

Debate Over 100% Renewable Energy

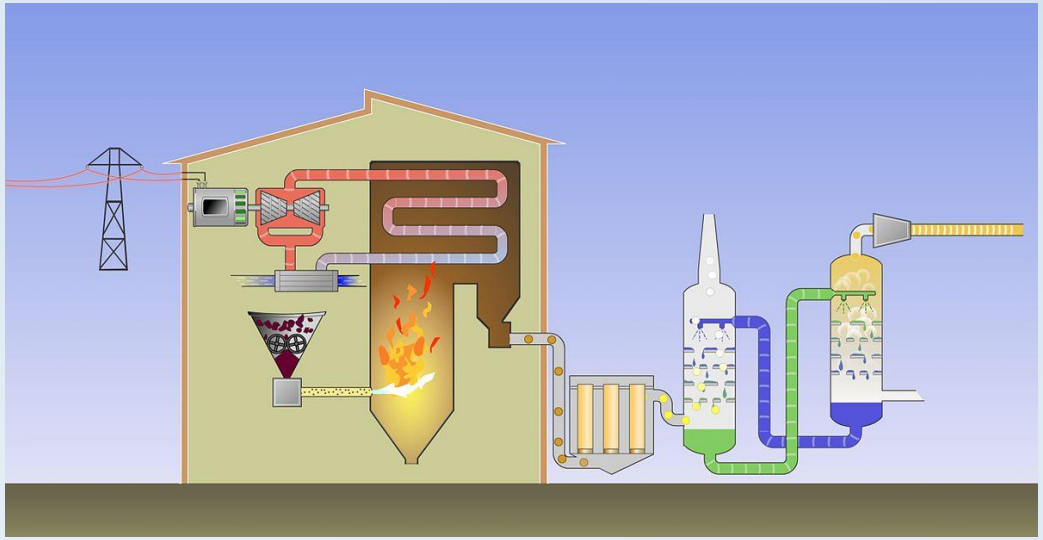
- Not about the climate imperative
- Not about deep decarbonization—reduce total C emissions to 80-100% globally by mid-century
- Not about cleaning the grid and moving transportation, heating, and industry to electricity
- General agreement that:
  - ✓ Increase demand for power, possibly as much as 150% by mid-century
  - ✓ Means grid will have to get bigger, more sophisticated, more efficient and more reliable while decarbonizing.

Debate Fundamentals

- How much can be done locally with distributed technologies and how much is utility scale build-out
- How much land will be consumed to build out the solar and wind needed and how realistic it is that can happen
- Cost
- Natural gas substituting for coal while the renewable energy kinks get worked out
  - ✓ Works up to a point but incompatible with decarbonization beyond 60% or so
  - ✓ And if you build NG plants to 60% you are stuck shutting them down to get past 60%

100% Renewable vs. Zero-Carbon

Will we need nuclear and CCS to provide balancing, or can we do it without them?



Optimal Balance

- "Assuming we could conjure up the political will for this kind of wholesale transformation to WWS … would we want to?"
- Is this the optimal balance of costs and benefits?
- Total-system cost relative to the larger portfolio of low-carbon options
- Fundamental question for all of us to be asking as we pursue this work

Pitched Battle

- “100% renewable energy is a better slogan, but that's not all it is,” said Karthik Ganapathy, a former 350.org staffer who worked for Sanders and now works for Democratic Rep. Keith Ellison of Minnesota. “We need to massively transition off fossil fuels, and dramatically scale up renewable energy. That's the main project. the rest is details that we can figure out on the margins.”
- Jesse Jenkins, an energy analyst getting his Ph.D at the Massachusetts Institute for Technology, who backs a more diverse low-carbon approach, said such details shouldn’t be glossed over. “I hear them, but I don’t think that’s the only way you can build a rallying cry,” Jenkins said. “In a movement, you need to lead and you should build support around viable solutions that work.”

Not Helping the Cause

- "They should realize they are beating dead horses and start getting on board and help solve the problem instead of being obstacles to the problem," Jacobson told me. Last November he filed a lawsuit against Christopher Clack, lead author of a report disputing one of Jacobson's studies, and the National Academy of Sciences that published Clack's report.
- "It's obviously ideal if everyone is rowing in the same direction," said John Coequyt, the Sierra Club's climate policy director. "But, there are really different concerns that different parts of the broad progressive community have on solving climate change, and that is going to result in different perspectives."

Why the Controversy Matters

- Conflict is erupting over the best technologies and messaging
- Experts worry fighting could stifle progress toward climate
- Divisions, brewing for years, escalating in the face of a Republican-run government that doesn't recognize the issue at all.

100% Renewable Trends

100% Clean Movement-International

- 2011 Go 100% Renewable Energy (Renewables 100 Policy Instititue
- 2013 REN21
- World Bank
- Climate Vulnerable Communities
- Top 11 countries: (Sweden, Costa Rica, Nicaragua, Scotland, Germany, Uruguay, Denmark, China, Morocco, the US, and Kenya)
- Global 100% RE Platform (5/8/17)

100% Clean Movement-Corporate

- RE100 Companies
- 2016 Corporate Advanced Energy Commitments
- Rocky Mountain Institute Business Renewables Center (BRC)
- WRI's Corporate Renewable Energy Buyers Principles

Businesses Jumping on Board

100% Clean Movement-Cities

- Renewable Cities, Simon Fraser Univ. Centre for Dialogue Vancouver, BC
- Sierra Club's Ready for 100%
- CDP today-100 cities reporting at least 70% RE

The Periodic Table of Profitable Climate Solutions

* = Ryan Original Films shooting episode featuring profitable climate solution companies. More here 12climatesolutions.com

Priority — 43 — Featured (12climatesolutions.com) — *
Symbol — Ap
Name — Airplanes
CO2 Saved (Gigatons) — 5.05

Contact the Author Insta / Fb / Tw @ryan2dotzero ryan@ryanjennings.net

6 E Educating Girls 59.6 *												7 F Family Planning 59.6	62 Ws Women Smallholders 2.06	
1 Rm Refrigerant Mgmt 89.4 *	5 T Tropical Forests 61.23 *											3 R Reduced Food Waste 70.53	4 P Plant Rich Diet 66.11 *	
36 Ac Alternative Cement 6.69	12 Te Temperate Forests 22.61											9 S Silvopasture 31.19	11 Ra Regenerative Agriculture 23.15 *	14 Tt Tropical Staple Trees 20.19
46 Ws Water Saving - Home 4.61	13 Pl Peatlands 21.57	2 W Wind Turbines Onshore 84.60 *	8 Sf Solar Farms 36.9	18 G Geothermal 16.6	20 N Nuclear 16.09	29 Wa Wave & Tidal 9.2	48 H Hydro 4.0	50 Co Cogeneration 3.97	76 Mw Micro wind 0.2	77 Ed Energy Storage Distributed N/A	82 Gf Grid Flexibility N/A	16 Ca Conservation Agriculture 17.35	17 Ti Tree Intercropping 17.20	53 Ri System of Rice Intensification 3.13
47 B Bioplastic 4.30	15 A Afforestation 18.06 *	39 Im Indigenous People Land Management 6.19	10 Rs Rooftop Solar 24.6 *	41 Sw Solar Water 6.08	22 Wo Wind Turbines Offshore 14.10	30 Md Methane Digesters 8.4	34 Bm Biomass 7.5	64 Ms Methane Digesters Small 1.9 *	68 We Waste to Energy 1.1	81 Eu Energy Storage Utilities N/A	78 M Microgrids N/A	19 Mg Managed Grazing 16.34	21 Cc Clean Cookstoves 15.81 *	23 Fr Farmland Restoration 14.08
55 Hr Household Recycling 2.77	35 Bo Bamboo 7.22	51 Pb Perennial Biomass 3.33	25 Cs Concentrated Solar 10.9	27 Dh District Heating 9.38	31 In Insulation 8.27	33 Lh LED Lighting Household 7.81	42 Hp Heatpumps 5.20	45 Ba Building Automation 4.62	54 W Walkable Cities 2.92	57 St Smart Thermostats 2.62	58 Lm Landfill Methane 2.50	24 Ir Improved Rice Cultivation 11.34	28 Ma Multistrata Agroforestry 9.28	60 C Composting 2.28
56 Ir Industrial Recycling 2.77	38 Fp Forest Protection 6.20	52 Cw Coastal Wetlands 3.19	59 Bi Bike Infrastructure 2.31	61 Sg Smartglass 2.19	71 Wd Water Distribution 0.87	44 Lc LED Lighting Commercial 5.04 *	73 Gr Green Roofs 0.77	79 Nz Net Zero Buildings N/A	80 Re Retrofitting N/A	66 Hs High Speed Rail 1.52 *	69 Eb Electric Bikes 0.96	65 Nm Nutrient Management 1.91	67 Fi Farmland Irrigation 1.33	72 Bc Biochar 0.81
			26 Ev Electric Vehicles 10.80	32 Sh Ships 7.87	37 Mt Mass Transit 6.57	40 Tr Trucks 6.18	43 Ap Airplanes 5.05	49 Cr Cars 4.00	63 Tp Telepresence 1.99	74 Tr Trains 0.52	79 Rs Ride Sharing 0.32			

Food
Transport
Women & Girls
Materials
Land Use
Buildings & Cities
Electricity and Generation

The Periodic Table of Profitable Climate Solutions categorises 80 innovative ways of reducing the impact of climate change through carbon reduction initiatives.

Companies engaged in delivering climate solutions can therefore be grouped by industry and by initiative.

This is important because climate related innovation is a leading indicator of financial performance and company success.

CREDITS & MENTIONS

PROJECT DRAWDOWN is the source of data for the prioritisation of climate initiatives and amount of carbon saved. http://www.drawdown.org/solutions-summary-by-rank

THE GLOBAL CARBON PROJECT for providing the planets overall burnable carbon budget of 2,800 Gigatons CO2. http://www.globalcarbonproject.org/carbonbudget/16/files/GCP_CarbonBudget_2016.pdf

TCFD (Task Force on Climate-Related Financial Disclosures) for their work on climate-related financial disclosures across governance, strategy, risk management and metrics & targets to reduce risks during the transition to a lower carbon economy.

CARBON TRACKER for their work on alignment of capital market actions with climate reality including calculation of the total carbon budget for the oil and gas sector https://www.carbontracker.org/wp-content/uploads/2017/10/2degrees-separation-infographic-V.4NE-01.png

Drawdown Top Ten Solutions

Rank	Solution	Sector	TOTAL ATMOSPHERIC CO2-EQ REDUCTION (GT)	NET COST (BILLIONS US $)	SAVINGS (BILLIONS US $)
1	**Refrigerant Management**	Materials	89.74	N/A	$-902.77
2	**Wind Turbines (Onshore)**	Electricity Generation	84.60	$1,225.37	$7,425.00
3	**Reduced Food Waste**	Food	70.53	N/A	N/A
4	**Plant-Rich Diet**	Food	66.11	N/A	N/A
5	**Tropical Forests**	Land Use	61.23	N/A	N/A
6	**Educating Girls**	Women and Girls	59.60	N/A	N/A
7	**Family Planning**	Women and Girls	59.60	N/A	N/A
8	**Solar Farms**	Electricity Generation	36.90	$-80.60	$5,023.84
9	**Silvopasture**	Food	31.19	$41.59	$699.37
10	**Rooftop Solar**	Electricity Generation	24.60	$453.14	$3,457.63

Thank you

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Clean Energy Transition

Transitioning from Fossil Fuel to Clean Energy

www.cleanenergytransition.net

Getting to 100% Renewables