

HOW MUCH OF OUR **ELECTRICITY** CAN WE GET FROM **SOLAR**?



IT'D BE **GREAT** IF WE COULD GET **ALL** WE NEED...

... BUT IN TRUTH, THE ANSWER IS A BIT **UNCERTAIN.**

I SEE A BRIGHT FUTURE ILLUMINATED BY **POLLUTION-FREE ENERGY!**

I SEE A **SQUIRREL.**

I SEE A **ROLLING BLACKOUT.**

by Grady Klein, Sajan Saini, and Warren Powell, BSE '77

SOME DAYS WE CAN **EASILY PREDICT** HOW MUCH SOLAR POWER WE CAN GENERATE...

... BUT ON **PARTIALLY CLOUDY DAYS**, WE **CAN'T.**



LOTS!



LOTS LESS!



UHM...

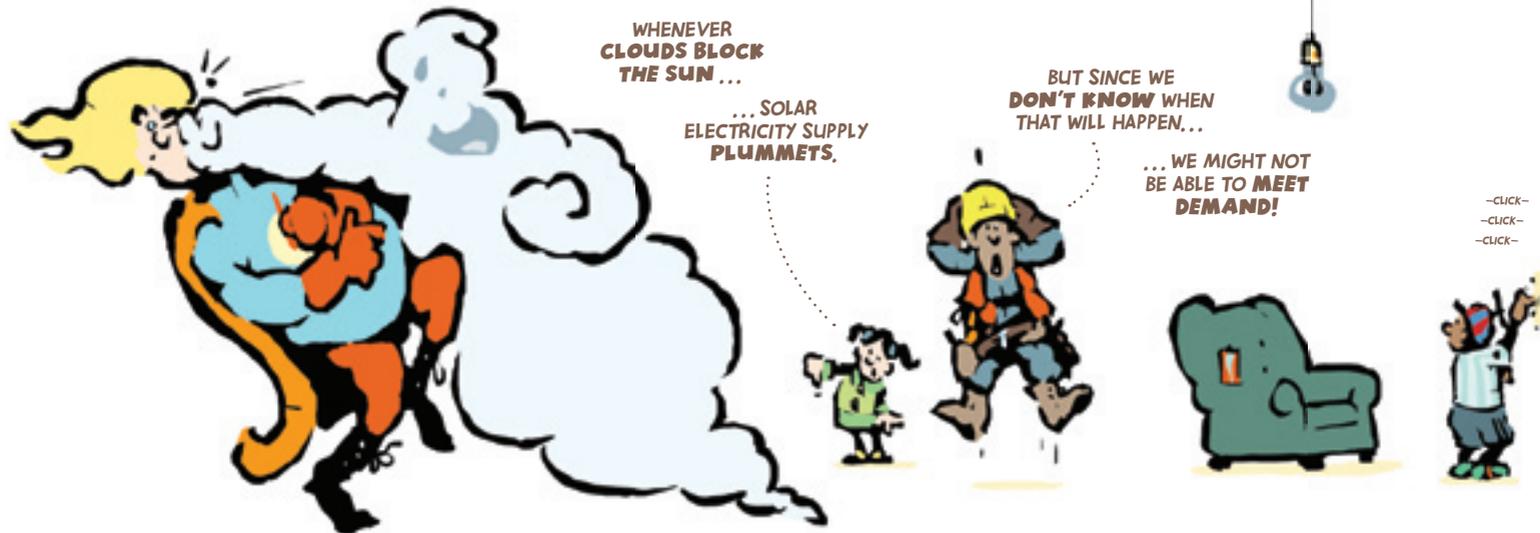
AND THAT CREATES A **BIG PROBLEM.**

WHENEVER **CLOUDS BLOCK** THE SUN ...

... SOLAR **ELECTRICITY SUPPLY PLUMMETS.**

BUT SINCE WE **DON'T KNOW** WHEN THAT WILL HAPPEN...

... WE **MIGHT NOT** BE ABLE TO **MEET DEMAND!**



UNFORTUNATELY, WE CAN'T YET SOLVE THIS PROBLEM WITH **POWER STORAGE.**



MONDO...

... BATTERY...

... JUST ...

-CLICK-
-CLICK-
-CLICK-

... TOO...

... **EXPENSIVE.**

AND WE CAN'T **SIMPLY RELY** ON **GAS OR COAL GENERATORS** AS **BACKUP.**

SOLAR OUTPUT CAN CHANGE IN **MINUTES...**

... BUT IT TAKES **HALF AN HOUR** TO FIRE UP **GAS TURBINES...**

... AND MORE EFFICIENT **STEAM POWER** TAKES **EIGHT HOURS.**



LIKE IT OR NOT, WE'LL ALWAYS NEED TO **ANTICIPATE** OUR **ELECTRICITY SUPPLY IN ADVANCE.**



OOPS, THE SUN JUST **WENT BEHIND** A **CLOUD.**

WE NEEDED TO **KNOW** THAT **YESTERDAY!**

WHICH MEANS THAT AS WE PLAN FOR A **BRIGHTER, CLEANER FUTURE...**

... WE'RE GOING TO HAVE TO **PREPARE FOR UNCERTAINTY.**

WE'RE **THE RENEWABLES.**

YOU CAN **COUNT ON** US, KID...

... EXCEPT WHEN YOU **CAN'T!**

NOBODY CAN **PREDICT** THE **FUTURE...**

... BUT **MATHEMATICAL MODELS** CAN HELP US **MAKE DECISIONS ANYWAY!***



*CASTLE LAB AT PRINCETON, LED BY PROFESSOR WARREN POWELL, BSE '77, EMPLOYS MATHEMATICAL MODELING TO MAKE BETTER DECISIONS UNDER UNCERTAINTY. THE LAB CURRENTLY IS DEVELOPING MODELS TO HELP INTEGRATE SOLAR AND WIND ENERGY ONTO THE GRID, STRUCTURE DECISIONS ABOUT WHEN TO TURN ON GENERATORS AND HOW TO DEPLOY AND MANAGE ENERGY STORAGE OPTIONS.