voting in the future, lest they be labeled hypocrites. Often such objections are rooted in defense: they *want* stuff, and your giving something up is a threat to their perceived moral "right" to have it. The sense of sanctimony and righteousness of the individual making sacrifices—even if not intentional—can be very offputting.

One other aspect of individual action is that it could influence others to follow, thus amplifying the individual's effect. This approach is perhaps most effective if others see benefits for themselves, and are not made to feel bad for not already being "woke" to the right side of the practice.

18.3 The Energy Trap

If we unwisely mount a response only *after* we find ourselves in fossil fuel decline—as crisis responders, not proactive mitigators—we could find ourselves in an energy trap: a crash program to build a new energy infrastructure requires up-front energy, for decades. If energy is already in short supply, additional precious energy must be diverted to the project, making peoples' lives seem even harder/worse.[20] A democracy will have a hard time navigating this decades-long sacrifice.

20: Amid consternation over energy shortfalls and likely high prices, pulling more energy away from people will not be popular.

Let's flesh this concept out a bit more. In the financial world, money can be borrowed on the promise of paying it back.[21] In this way, something is created from nothing, essentially. Modern monetary systems are based on *fiat currency*, rather than being tied to physical gold or silver. This means money can be "willed" into existence by the financial system. Energy does not work that way. To build a hydroelectric dam, solar panels, wind turbines, or a nuclear plant, all the energy must be available up front. Nature offers no financing!

21: . . . with interest

Recall from Sec. 14.3.1 (p. 231) that the EROEI, or energy returned on energy invested, describes the ratio of output energy over the lifetime of the resource to the input energy needed to secure it in the first place. For many cases, like a hydroelectric dam, nuclear plant, wind turbine, or solar panel, most of the energy *input* happens before any energy is delivered. In other cases, like biofuels, the investment may be more drawn out and seem more like an efficiency. In the context of the energy trap, we will focus on the input as an up-front investment.

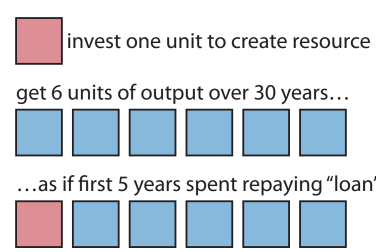

Figure 18.5: Energy "payback" time for 30 year resource with EROEI of 6:1.

Example 18.3.1 If a solar panel has an EROEI of 6:1, that "1" unit has to be paid *up front*, even though ultimately the panel will more than pay for itself, energetically. How many years of the panel's energy needs to be available up front if the panel lasts 30 years in the sun?[22]

22: Any EROEI estimate must assume some resource lifetime in order to compute the amount of energy delivered.

The 6 in the EROEI figure relates to the total output of the resource. So we equate 30 years of operation to the number 6, meaning that 1 "unit" is 5 years of output (Figure 18.5). Since the input is 1 unit (in

6:1 construction; see Sec. 14.3.1; p. 231), we conclude that it takes 5 years of the panel's output energy to fabricate the panel. So its first five years are spent paying off the "loan," in a sense.

As another example, development of a resource that will last 40 years and whose EROEI is 10:1 will require 4 years of its energy output ahead of time[23] to bring it to fruition.

23: . . . from a resource that is *already* producing energy

Example 18.3.2 In order to replace the current 15 TW[24] now derived from fossil fuels with a renewable resource whose lifetime is 40 years and EROEI is 10:1,[25] what options might you suggest for diverting the 15 TW into construction and how long would it take under those options?

24: ~80% of the 18 TW total

25: . . . or a combination of resources having similar EROEI and lifetime

It takes four years of the ultimate resource output to create the resource in this scenario. In one extreme, *all* 15 TW from fossil fuels could be diverted into the effort over a four year period[26] to develop 15 TW of the new resource. Or half of the 15 TW fossil resource could be dedicated to the effort over 8 years, or a quarter over 16 years, or 10% over 40 years.[27] Choosing this last path for a 40-year resource means "starting over" at this juncture, essentially forever re-investing 10% of available energy into perpetuating a resource with EROEI of 10:1.

26: . . . leaving nothing for societal needs

27: Even a 10% diversion will "hurt" and be unwelcomed.

Imagine now that we find ourselves having reduced access to oil,[28] driving prices up and making peoples' lives harder. Now the government announces a 16 year plan to divert 25% of energy into making a new infrastructure in an effort to reduce dependence on fossil fuels. That is a huge additional sacrifice on an already short-supply commodity. Voters are likely to respond by tossing out the responsible[29] politicians, installing others who promise to kill the program and restore relief on a short timescale. Election cycles are short compared to the amount of time needed to dedicate to this sort of major initiative, making meaningful infrastructure development a difficult prospect in a democracy. And this is before addressing the likely contentious fights about *what* the new infrastructure should be, out of the table of imperfect[30] options.

28: . . . as the most plausible example; the first to peak

29: . . . in the true sense of the word

30: See Chapter 17, for instance.

Now it is perhaps more apparent why this is called an energy trap: short-term political and economic interests forestall a proactive major investment in new energy, and by the time energy shortages make the crisis apparent, the necessary energy is even harder to attain. Short-term focus is what makes it a trap.[31]

31: Is this a human limitation?

One wonders how democracies will fare in the face of declining resources. The combination of capitalism and democracy have been ideal during the growth phase of our world: efficiently optimizing allocation of resources according to popular demand. But how do either work in a decline scenario, when the future is not "bigger" than today, and may involve sacrifice? We simply do not yet know. This is a giant unauthorized experiment that is not operating from a script. Chapter 19 will return to this notion.