Community-Scale Composter design guide

AdkAction

NYS P2I New York State Pollution Prevention Institute

Camp Treetops North Country School

compost for good reimagining waste

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ANCA

Acknowledgements:

In 2016, North Country School and Camp Treetops, in partnership with the Adirondack North Country Association (ANCA), received a $35,000 grant through the New York State Energy Research and Development Authority (NYSERDA) to design a low cost, in-vessel drum composter for medium to large communities. This pilot composter was so successful that $120K was awarded by NYSERDA to build and install 3 additional units.

North Country School and Camp Treetops opted to distribute the 3 systems to remote site hosts. Concurrently, a boarding school in New Jersey has constructed and is operating a system following the North Country School and Camp Treetops model. As the lead project designer, I, John Culpepper, realized the need for a document to support current and future organizations and individuals operating the in-vessel composter design. I have drafted this manual to offer such support.

All of the ideas that led to the development of this system are a result of time spent with people smarter than, or more experienced than me. I was simply the conduit through which this idea of designing and building an in-vessel composter came to be. I acknowledge legions of others who have inspired, taught, or otherwise helped me in this. I also acknowledge and appreciate the extent to which various executive directors at North Country School and Camp Treetops and the all-volunteer board of trustees have allowed me the opportunity to explore this and many other sustainability initiatives for our campus. I would like to express my appreciation to the following individuals and organizations whose support has allowed me to experiment with various versions of this project:

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NYS P2I

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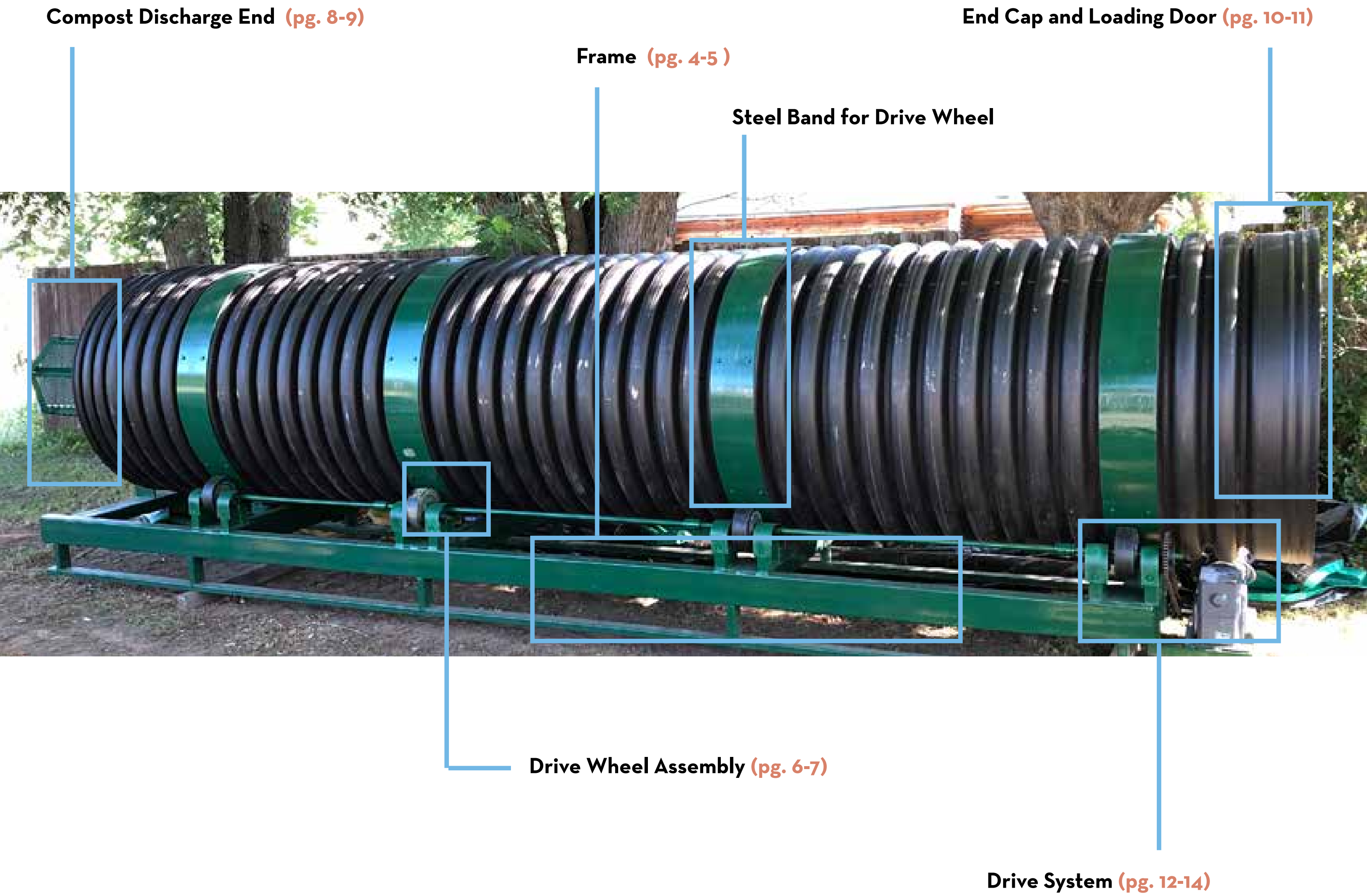
About Compost for Good

Compost for Good grew out of John Culpepper's composting work at North Country School and Camp Treetops. It was the school's longstanding commitment to sustainability and John's passion for composting that inspired the design and build of an innovative community-scale composter.

The first of these composters was installed at North Country School and Camp Treetops, is operated by the students and campers, and processes all of the food waste of the organization. This operating manual is designed to accompany that composter.

With the success of this composter, there was a growing demand from communities around the world for more information about this design. To meet that demand, John founded Compost for Good with Jennifer Perry and Katie Culpepper. Though our reach is increasingly global, we are building from a local focus. We are grateful to have organized under AdkAction, as one of their projects. ADKAction is a nonprofit organization that creates projects that address unmet needs, promote vibrant communities, and preserve the character of the Adirondacks. Working with ADKAction strengthens our ability to help communities within the Adirondacks and beyond to implement composting systems that meet their unique needs.

compost for good reimagining waste



CONSTRUCTION DISCLAIMER:

I have tried my best to provide accurate descriptions, manufacturer and part numbers for all of the component parts. If I have made a mistake then please let me know so that I can correct it. For some components I identified where the component was purchased. For others I simply identified the manufacturer of the component. Please feel free to make alterations in this design and share those with me. I am reasonably sure that others will find easier ways to put this together, and perhaps with less expensive, or different components. I would like to share improvements on this design with the rest of the world.

At the time of this writing, there are several composters that have been built or are being built based on this design or a modification of this design. The oldest of these has been in continuous operation for over six years. Our purpose in putting this design out there is so that others can modify the design to meet their particular needs. This guide covers only the basic construction considerations for this composter. Supplemental resources, such as the operating manual for this composter and site guidance document can be found on our website. Technical assistance and design consultation are also available upon request. For those who are interested in this composter design, but do not have the skills necessary to construct the unit, we are building the capacity for manufacturers in our local area. Please get in touch with us if you are interested in having a composter built and delivered to your location.

Updates to the design: *We have recently obtained a grant that will allow us to create a new design that is simpler, eliminating all welding and eliminating the steel bands that wrap around the drum. We are doing this with the intent of reducing the complexity of the buildout and therefore the cost. If we are successful then we envision a day when the parts for these units can be manufactured in Upstate New York, and shipped to areas where they can be bolted together on site. We hope to have that new design available by the end of 2021 or the beginning of 2022.*

At the end of this design document, on page 17, you will find some preliminary thoughts on how the design presented in this document might be improved and simplified. These ideas are not tested, but reflect the continued effort towards decreasing cost of build out and simplicity of design.

— John Culpepper

ABOVE: An example of the kind of shop needed for building one of these composters.

AT TOP: HDPE Culvert (Composter Drum), 4' diameter x 20' length, purchased locally.

NOTE: The diameter configuration of the ribs on the drum sometimes differ; adjustments may be needed to accommodate.

1) 3″x 3″x ¼″ End Plate
• Cut from 3″ x ¼″ flat stock steel and welded to the end of the 3″ x 3″ angle iron, with a hole drilled into it for the bolt.

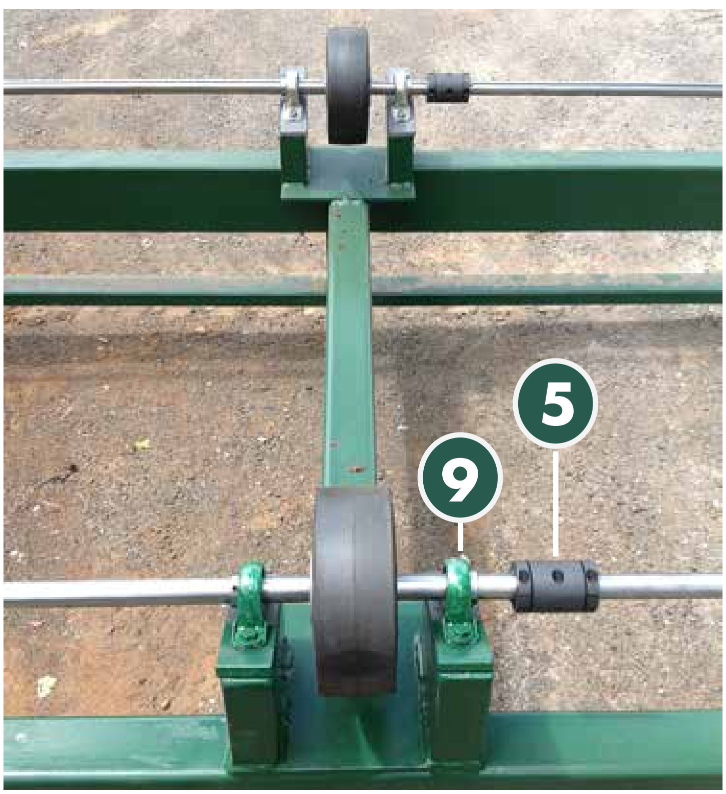
2) 3″x 3″x ¼″ Angle Iron

3) Two pieces of 8″x ¼″ Flat Steel Rolled 54½″ (+ or -)

*The steel bands were rolled into half circles at our local steel shop, then we welded the two half circles in place, on the drum. Alternately, tabs could be welded onto the ends of the half circles then the half circles bolted together.

NOTE: See corresponding diagram numbers on the last page for part information and quantities

Drive Wheel Assembly



4) 1″ Shaft with ¼″x⅛″ Full Keyway

5) High-Grip Clamp-On Rigid Shaft Coupling
(McMaster-Carr Part # 9800T14), shown painted and unpainted

6) 3″x 6″ x 3⁄16″ hollow structural steel

7) 3″ wide rubber cover
- Protects the bearings from liquid leaking from the drum
- These can be cut from any durable, bendable material, and screwed into the C-channel with self tapping screws.

8) Drive Roller *(McMaster-Carr Part # 61065K17)*

9) Stamped-Steel Mounted Ball Bearing
(McMaster-Carr Part # 5913K64) 3)
- Bearing tolerance: ABEC-1
- 1″ bore diameter to fit the fully-keyed steel drive shaft
- Attached to welded steel cap on C-shape structural steel

4) Fully-Keyed 1045 Steel Drive Shaft
- 1″ diameter, ¼″ keyway width
- 18″ length, passes through keyed drive roller and mounted ball bearings

8) Oil-resistant Keyed Drive Roller
(McMaster-Carr, Part #61065K17)
- 1″ bore diameter for keyed steel drive shaft

10) C-channel Structural Steel Pieces (left and right)
- Bias-cut for welding to steel base plate at a 20° angle
- Steel cap welded to top to attach mounted ball bearing
- See detail at right

11) Flat Steel
- Dimensions: 3/8″ thick, 10″ x 10″
- Top plate supports two angled C-channel steel pieces

12) 4′ x 4′x ¼″ Steel End Cap
• This was cut from a 4′ x 8′ piece of steel purchased locally.

13) 12″ x 12″ x ⅛″ Flat Steel
• This was cut from a larger piece

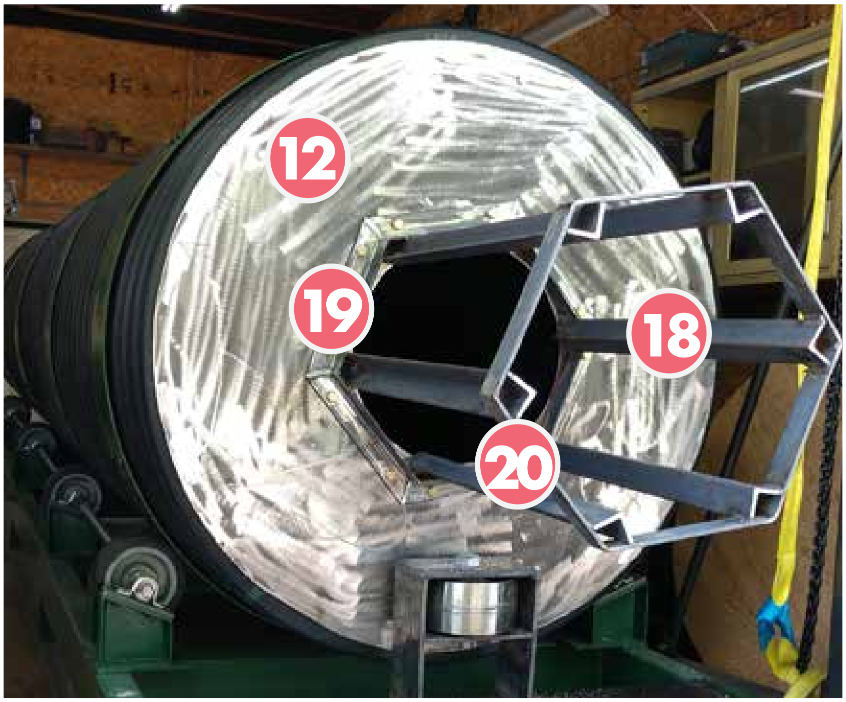
14) Rubber Cover
• These can be cut from any durable, bendable material
• Similar to diagram no. 7.

6) 3″ x 6″ x 3⁄16″ Structural Steel

15) 1½″ x 3″ x 3⁄16″ Steel

16) Metal Wheel
(McMaster-Carr Part # 2442T33)

Compost Discharge End



1) End Plate (from inside the drum)

12) 1/4" Steel End Plate (unpainted)

• Attached with 6 bolts through 3" x 3" flanges welded to 3" x 3" angle iron running inside the full length of the culvert. The end caps are bolted through these flanges.

17) Sheets of 1/2" expanded metal

• welded where they come together

18) 2"x 2"x ¼" angle steel

19) 2"x 2"x ¼" angle steel

20) 2"x 3⁄16" flat steel

End Cap and Loading Door

Another interior view

21) 3/4" Plywood End Cap

22) Plywood Door

- 3/4" thick marine-grade plywood
- Mounted with steel hinges to swing outward

23) Barrel Latch Closure

24) ⅝" Bolt, Grade 8

- Secure plywood end cap to 3" x 3" steel flanges that are welded onto the 3" x 3" angle iron pieces

25) ¾" Marine Plywood

- Custom cut piece to which the barrel latch closure and hinges attach

26) Hinge

27) "Female end" of HDPE drum

28) 2HP Single Phase Trans-Power Motor
(Kamen Industrial Technologies Part # CL3516TM)
• If using a 3-phase motor, use a 2HP Trans-Power motor, model TPE2R18C/C145TC

8) Oil-resistant Keyed Drive Roller
(McMaster-Carr Part # 61065K17)

6) 3"x 6" x 3⁄16" Hollow Rectangular Structural Steel Frame

29) Double-Strand Sprocket
(McMaster-Carr, Part #2784K25)
• For connecting two ANSI roller chain #40 between each large sprocket and motor/worm gear reducer.

30) ANSI #40 Chain *(McMaster-Carr, Part #6261K173)*

31) Steel support deck for motor and speed reducer
• 14½" x 20½" x ⅜"

32) Boston Gear Worm Gear Speed Reducer
(Kaman Industrial Technologies, F738-60E-B7-J)

2) 2" x 2" x ¼" Angle Frame

33) Ball-bearing Idler Sprocket
(Kaman Industrial Technologies, Part # MSG40BB18H)
• ½" pitch, 18 teeth, ⅝" bore diameter,
• Provides tension to roller chain, compatible with ANSI roller chain #40

10) C-shape Structural Steel Pieces (left and right)

• Bias-cut for welding to steel base plate at a 20° angle

• Steel cap welded to top to attach mounted ball bearing

6) 3" x 6" x 3⁄16" Cross Member

33) Ball-bearing Idler Sprocket

(Kaman Industrial Technologies, Part # MSG40BB18H)

• ½" pitch, 18 teeth, ⅝" bore diameter,

• Provides tension to roller chain, compatible with ANSI roller chain #40

28) 2HP Single Phase Motor

(Kamen Industrial Technologies Part # CL3516TM)

• If using a 3-phase motor, use a 2HP Trans-Power motor, model TPE2R18C/C145TC

3) Steel Drum Bands
• 8″ wide, 1/4″ thick

4) Fully-Keyed 1045 Steel Drive Shaft
• Fully-keyed for use with high-grip clamp
• Connects ball-bearing/roller wheel assemblies along entire length of composter
• Cut such that the couplers are close to the wheel assembly
• Able to be cut shorter, if necessary

27) HDPE Culvert (Composter Drum)
• 4′ diameter x 20′ length, purchased locally

31) Deck for Motor and Gear Reduction Box

34) Finished-Bore Sprocket
(McMaster-Carr, Part #6236K361)

35) 1½″ x 3″ x ³⁄₁₆″ Hollow Rectangular Structural Steel "Stiffening Bar"

36) Slide in Wheel
• This was custom built to allow the entire composter to be slid into a 40-ft shipping container. This piece is removed once the composter is set.

Parts and Quantities

DIAGRAM NO.	PART	QUANTITIES
1	**3″ x ¼″ flat stock steel**	~10 ft.
2	**3″ x 3″ x ¼″ angle iron**	~120 ft.
3	**8″ x ¼″ x 54½″ flat steel, rolled**	8
4	**Fully-keyed steel drive shaft, 1″ x ¼″ x ⅛″** (cut so the couplers are close to wheel assemblies)	Two 20-ft. lengths
5	**High-grip clamp-on rigid shaft coupling** (McMaster-Carr, Part #9800T14)	6
6	**3″ x 6″ x 3⁄16″ hollow structural steel**	~60 ft.
7, 14	**Custom-made rubber covers (**Can be cut from any durable, bendable material)	3
8	**Oil-resistant keyed drive roller** (McMaster-Carr, Part #61065K17)	8
9	**Stamped-steel mounted ball bearing** (McMaster-Carr, Part #5913K64)	16
10	**C-channel structural steel, 2″x 6″ x 3⁄16″**	~6 ft.
11	**10″ x 10″ x ⅜″ flat steel**	1
12	**Steel end cap cut from 4′ x 4′x ¼″ piece of steel**	1
13	**12″ x 12″ x ⅛″ flat steel**	1
15	**1½″ x 3″ x 3⁄16″ hollow structural steel**	Two 24′-ft. lengths
16	**8″ metal wheel** (McMaster-Carr #2442T33)	1
17	**1/2″ expanded metal**	One 4′x′8′ sheet
18	**2″x 2″x ¼″ angle steel**	16 ft.
19	**2″x 2″x ¼″ angle steel**	6 ft.
20	**2″x 3⁄16″ flat steel**	6 ft.
21-22, 25	**3/4″ marine-grade plywood** (for end cap, door and other support pieces)	~34 ft.
23, 26	**Purchased from a local hardware store** (one heavy-duty barrel latch closure and two hinges)	
24	**⅝″ x 2½″ bolts, grade 8**	12
27	**4′ x 20′ HDPE road culvert**	1
28	**Baldor 2HP Single Phase Motor** (Kaman Industrial Technologies, CL3516TM)	1
29	**Double-Strand Sprocket, 1 ⅝″ (**Kaman Industrial Technologies, Part #MSG 40BS19)	1
30	**ANSI #40 Roller Chain** (McMaster-Carr, Part #6261K173)	~20 ft.
31	**Steel support deck for motor and speed reducer:** 14½″ x 20½″ x ⅜″	1
32	**Boston Gear Worm Gear Speed Reducer** (Kaman Industrial Technologies, BOS F738-60E-B7-J)	1
33	**Ball-bearing Idler Sprocket, ⅝″** (Kaman Industrial Technologies, MSG 40BB18H)	2
34	**Finished-bore Sprocket** (McMaster-Carr, Part #6236K361)	2
35	**1½″ x 3″ x 3⁄16″ structural steel**	2
MISC:	**½″ x 4″ bolts, grade 8**	80

Potential Design Changes

While we have proven success with the design as is, we continue to strive to increase the simplicity of design and decrease the cost of building.

The ideas below are just potential components of an updated design and are presented in no particular order, and with no promise that they will prove to be practical or possible.

1. For the frame, instead of using hollow rectangular structural steel (reference #6), we are considering c-channel steel, bolted together with washers designed to accommodate the curve at the corners of c-channel steel.
2. We are considering eliminating the steel disk (reference #12) at the discharge end, using two sheets of ¾ inch marine plywood instead. The single piece of ¾ inch marine plywood that we used on the loading door end of our original composter has held up well for six years.
3. We are looking for ways to eliminate the steel bands (reference #3) by using a wider drive wheel that rests directly on the exterior of the drum, or using a triple wall drum instead of a double walled drum.
4. The six 3 inch x 3 inch angle iron pieces on the interior of the drum (reference # 2) provide rigidity for the polyethylene drum and also allow the material inside of the drum to tumble. We are considering bolting these angle iron pieces through the drum, and through a flat piece of steel that runs parallel to the drum. We are reasonably confident that as long as the 20-foot long steel pieces are flat enough, they won't prove to be a problem for rotation. If this works, then we would recommend that operators stop drum rotation such that the drive wheels, or at least the drive wheels bearing the brunt of the weight of the loaded drum, come to rest on the steel plate. That way, there would be less chance to deform the polyethylene drum during the periods of non rotation.
5. Instead of utilizing two chains (reference #30), with the double sprocket on the reduction gear, we believe that we can utilize a single, longer chain to drive both axles.
6. We are looking into repositioning the drive system so that a simple plywood box can be added to provide safety protection from the moving parts of the drive system. For the drive wheels, we believe that we can find a way to add simple plywood panels that run from the frame to close to the drum, covering up all of the drive wheels.
7. We are considering a hydraulic drive system that could rotate the drum very slowly, and continuously.
8. For remote locations that choose to use a photovoltaic system to drive the drum rotation, we are considering a simple inverter system hooked up to the drive motor, unless the inverter, etc. is more expensive than the DC motor that would be needed. Another circuit would use the DC electricity produced by the PV panels to charge to battery storage.