

DIY Android Home Energy Monitor

Use Android and webcams to chart your home energy use.



android meets energy

Lately we've been tinkering with deploying **Android beyond the phone** (using Google's Android to connect devices to each other and the web), so we thought we'd see if we could leverage the efficiency of Android on a **BeagleBoard**, the accessibility of wireless webcams, and the ease of cloud computing to track the ups and downs of our metered utilities.

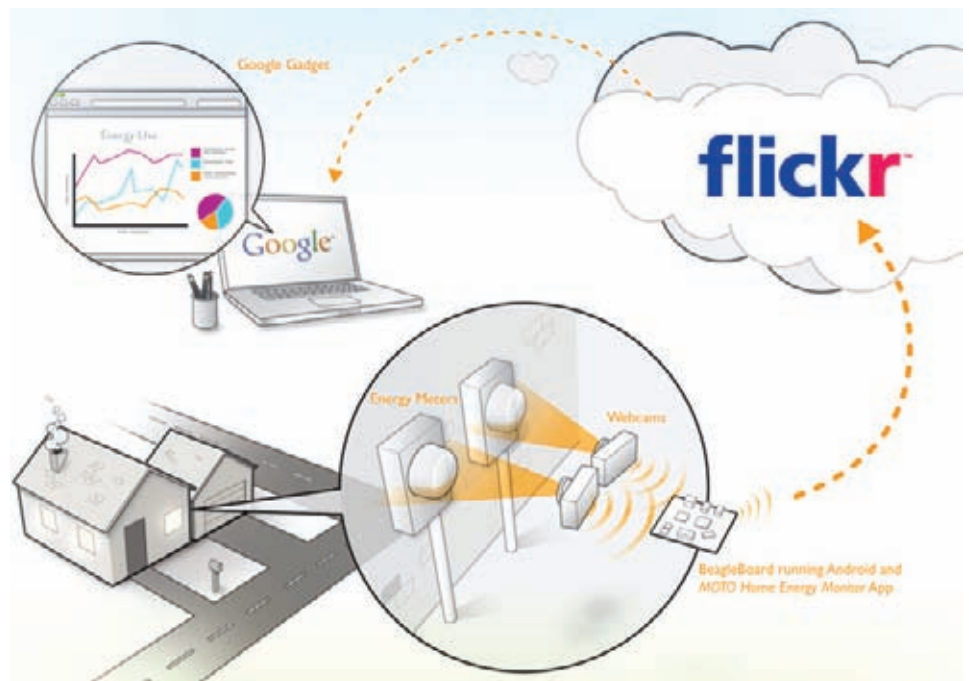
Why webcams? While there may be a few compelling (low-cost, low-impact) **products** out there to monitor your electric meter, there are no comparable products for reading gas or water meters.

So until the really smart grid arrives, here's how to chart your whole utility spend on your own Google homepage.

THE DIY ANDROID HOME ENERGY MONITOR ECOSYSTEM

The MOTO DIY Android Home Energy Monitor (AHM) utilizes an average wireless network. Wireless webcams take pictures of the ever-changing dials on the user's utility meters. A BeagleBoard running Android and the MOTO AHM custom applications push the pictures up to a **Flickr** photo set.

MOTO AHM application prompts and transcribe numbers into your Flickr image tag. Saving the image spurs the MOTO Labs' Google Gadget will automatically chart meter activity on the user's Google home page.



DO IT YOURSELF: STEP-BY-STEP INSTRUCTIONS

STEP 1: Locate Your Meters

This is a big variable, especially from utility to utility. Meters can be inside and outside. DH's meters were inside his garage, thus we had the ease of not having to weather-guard or security. This is where then you begin thinking about how you're going to mount your cameras.



STEP 2: Collect the gear

Gather and/or purchase the following:

- [BeagleBoard](#)
- 1GB SD Card
- [Linksys WVC54GCA](#) wireless monitoring camera - or any other camera which runs a web server and provides a URL for getting the current still image.
- Internet connection
- Wireless network
- Mounting hardware (see Step 3)
- [Low-power light](#) (if your meters will be in the dark)
- [USB to AC converter](#) for light

For BeagleBoard setup:

- Monitor with HDMI
- Powered USB hub
- USB to ethernet adapter
- USB keyboard

For Tweet-A-Watt setup:

- [Kill-A-Watt](#)
- [Tweet-A-Watt kit](#)
- [Twitter account](#)

Required software:

- BeagleBoard SW package to be placed on the SD card (see Step 4); includes Android and MOTO AHM app:
 - [U-boot Kernel Image](#)
 - [Android File System](#)



STEP 3: Mount the cameras

For the electric meter, we went hardware simple by strapping two #96 hose clamps around the electric meter glass. We then slipped a sheet metal "stick" (pre-drilled to match the mounting plate of the webcams) and shimmed it with 3M 4991 VHB tape.

For the gas meter, we used the same simple materials and technique, except we had to double up on the hose clamps to cover the girth of the meter. We also had to mount from the side and then utilize the camera's swivel mount arm to get the right angle.



STEP 4: Setup the Software

Prepare the SD Card with the MOTO Android Image.

1. Configure U-Boot on BeagleBoard with the following parameters:


```
set loadaddr '0x80200000'
set mmc_kernel 'mmcinit; fatload mmc 0 ${loadaddr} ulmage'
set boot_mmc 'run mmc_kernel; set bootargs ${bootargs_mmc};
bootm ${loadaddr}'
set bootargs_mmc 'console=ttyS2,115200n8 noinitrd root=/dev/
mmcbk0p2 rootfstype=ext3 init=/init rootwait'
set bootcmd 'run boot_mmc'
```
2. Format an SD Card to have two Partitions using fdisk, mkfs.ext3 and mkfs.vfat.
 - a) First Partition should be FAT
 - b) Second Partition should be EXT3

Example:

Device	Boot	Start	End	Blocks	Id	System
/dev/sdb1		1	7	56196	6	FAT16
/dev/sdb2		8	987	7871850	83	Linux

3. Copy ulmage to the FAT partition.
4. Untar the rootfs.tar.gz onto the EXT3 partition using sudo.

STEP 5: Setup the Hardware

1. Follow manufacturer instructions to get camera(s) onto WiFi network. Take note of each camera's IP address.
2. Insert SD card into Beagle Board's SD slot.
3. Connect Mote, keyboard and USB Ethernet adapter to powered hub and attach hub to beagle board's Mini-B connector.
4. Connect Beagle Board to Ethernet port on wireless router.
5. Attach monitor to HDMI port on Beagle Board.
6. Power up the Beagle Board.



STEP 6: Configure Android, Flickr, and MOTO AHEM application

Configure Flickr:

- Photos taken will be uploaded to a photoset on a Flickr account. This requires a Flickr account and a Flickr API key.
- After creating and logging in to a Flickr account go to <http://www.Flickr.com/services/> to apply for an API key. **Be sure to use Mobile Application as the authentication mode for your Flickr application with full delete privileges.** Make a note of the API key, API Secret, and Authentication URL for your Flickr application.
- Go to the Authentication URL supplied by Flickr for your application. Sign in to the Flickr account you want images uploaded to and allow your Flickr application full access to this account. **Take note of the nine digit code Flickr returns.**

Configure Android:

1. On a computer that is connected to the same network as the Beagle Board, install the Android SDK and put the tools directory in your path.
2. Create an environment variable called ADBHOST and assign it the IP address of the beagle board which is statically set to 192.168.0.53.
3. At a command prompt enter the adb kill-server command followed by adb-shell. After a few moments a command prompt on the Android device should appear.
4. At a command prompt enter the following command:
adb pull /data/data/com.moto.HomeEnergyMonitor/shared_prefs/com.moto.HomeEnergyMonitor_preferences.xml .

This will retrieve the Home Energy Monitor service's configuration file. The file looks something like this:



```
<?xml version='1.0' encoding='utf-8' standalone='yes'?>
<map>
<string name="cameraURL0">http://192.168.0.110/img/snapshot.cgi</string>
<string name="cameraURL1">http://192.168.0.111/img/snapshot.cgi</string>
<int name="numCameras" value="2" />
<int name="cameraPollInterval" value="3600" />
<string name="twitterUserName"> </string>
<int name="numAppliances" value="2" />
<string name="twitterPassword"> </string>
<int name="maxImages0" value="0" />
<int name="maxImages1" value="0" />
<string name="applianceName0">Television</string>
<string name="flickrPhotoSet0">gas</string>
<string name="flickrPhotoSet1">electric</string>
<string name="applianceName1">Refrigerator</string>
<string name="flickrAuthenticationToken"></string>
<int name="appliancePollInterval" value="120" />
<string name="flickrApiKey"></string>
<string name="flickrApiSecret"></string>
</map>
```

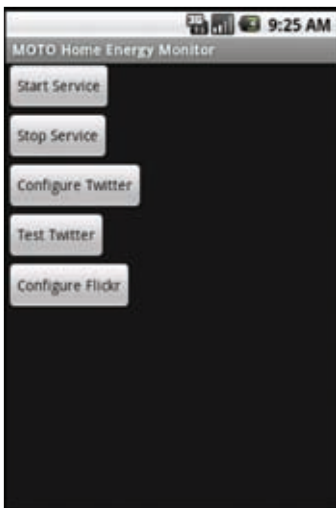
Edit the following parameters to match your setup.

Name	Description
numCameras	The number of cameras attached
cameraURL + CAMERAINDEX	The URL of each cameras still image page
flickrPhotoSet + CAMERAINDEX	The flickr photoset to upload images to. One for each camera.
maxImages + CAMERAINDEX	The maximum number of images to allow in each cameras flickr photoset. Older images will be deleted. <u>A value of zero means unlimited number of images.</u>
cameraPollInterval	The number of seconds between taking a photo
flickrApiKey	The api key assigned by flickr to this application
flickrApiSecret	The api secret assigned by flickr to this application
numAppliances	The number of kill-a-watt devices to poll
appliancePollInterval	How often to poll the kill-a-watt devices
applianceName + APPLIANCEINDEX	The name of each appliance attached to a kill-a-watt device
twitterUserName	User name to post statuses to
twitterPassword	Password of account to post statuses to

- When finished, save the file.

Configure MOTO Android Home Energy App:

- Enter the following at a command prompt:
adb push com.moto.HomeEnergyMonitor_preferences.xml/data/data/com.moto.HomeEnergyMonitor/shared_prefs/com.moto.HomeEnergyMonitor_preferences.xml
- On the BeagleBoard start the MOTO Home Energy Monitor application. The following window should appear:



- Select Configure Flickr which will display the following screen



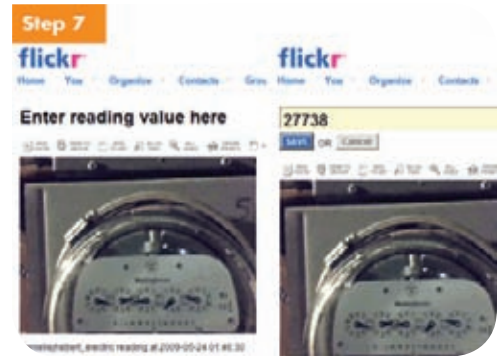
9. Enter the nine digit authentication code and select OK. The application will attempt to authenticate, when it succeeds then click OK. Then select Start Service from the main screen.
10. When an image is taken it will be uploaded to Flickr and inserted into a photoset. The title of each new image is "enter reading value here". Change this to the meter reading you see in the image.

STEP 7: Tag images in Flickr

Log on to your Flickr account.

Identify the number displayed on the meter; click on the photo title, and enter the number as the title for the image. This will be automatically read by the Google Gadget, so be sure to leave it just the plain number (no spaces, extra characters).

Need help reading your meter? Check with your local utility. For us, we used this [link](#).



STEP 8: Build and Set Up Tweet-A-Watt

Assemble the Tweet-A-Watt kit per kit instructions.

Once the Home Energy Monitor Service is running we can start the tweet-a-watt python script.

- Make sure the Xbee receiver is plugged in to the USB hub attached to the BeagleBoard.
- On your pc type *adb shell* at a command prompt.
- At the Android shell command prompt enter

python /data/wattcher/wattcher.py

In the MOTO AHEM app settings, click the Configure Twitter button, and add your Twitter account information.

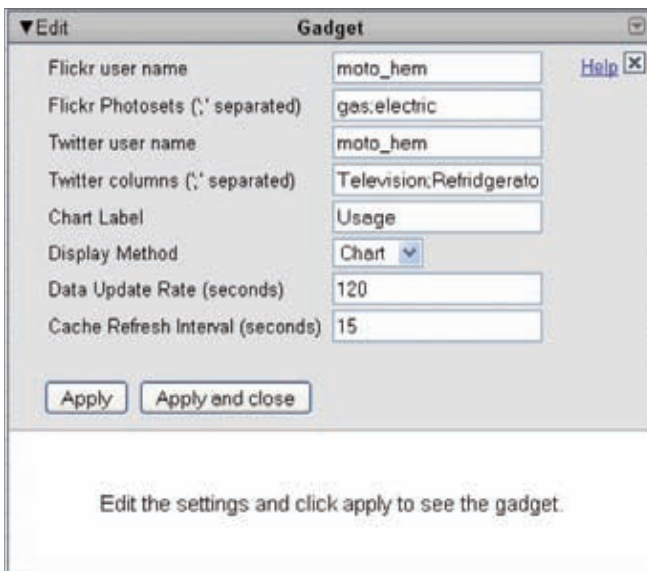


STEP 9: Set Up MOTO Labs' Google Gadget

To view recent readings use the Google Gadget. The URL of the gadget is:
http://motoprojects.com/motounderground/hem/chart_gadget.xml

To view it in iGoogle page click Add Stuff. Then select Add feed or gadget and enter the above URL and click Add. Google will display a security warning that you are inserting a feature not created by Google. Click OK and return to your iGoogle page.

Google gadget settings:



The screenshot shows a 'Gadget' settings window with the following fields and values:

Field	Value
Flickr user name	moto_hem
Flickr Photosets (',' separated)	gas,electric
Twitter user name	moto_hem
Twitter columns (',' separated)	Television,Refridgerato
Chart Label	Usage
Display Method	Chart
Data Update Rate (seconds)	120
Cache Refresh Interval (seconds)	15

Buttons: Apply, Apply and close

Help icon: Help X

Footer text: Edit the settings and click apply to see the gadget.

Make sure that the information in your Gadget settings matches your Flickr account information.

MORE STEPS

- Definitely would prefer to utilize OCR so we can eliminate the klugey transcription step. Anyone interested?
- More fun might be to hack the [Black and Decker Power Meter](#) to populate the MOTO Google Gadget.

CONTEXT

- You may have heard about the \$4.5 billion the February stimulus package set aside for the build-out of our nation's [smart grid](#), but check out this description of [billions more](#) for associated technologies.
- [A recent report by Deloitte](#) predicted "that in 2009, SmartGrid companies may generate \$25 billion in revenues, and represent the biggest and fastest growing sector in the GreenTech - possibly even the entire - technology market."
- Read through a history of Earth2Tech's editor Katie Fehrenbacher's posts tagged "energy" and you'll start to understand the players, the pace, and high stakes involved in this massive energy infrastructure upgrade. Check out also the archive of their recent [GreenNet](#) conference..
- It was Fehrenbacher's survey piece on [Energy Dashboards for the Home](#) that tipped us over to this somewhat reactionary choice of webcams for our metering system.
- Energy pundit and engineer Saul Griffith's [Wattzon](#) personal calculator tool might offer the smartest vision for a user experience that could fulfill this drive to know (and thus change) what we consume.
- [Google Power Meter](#) is the one to watch, of course. Read [Google's letter](#) to the California Public Utilities Commission where they assert the public's right to access personal real-time smart grid data.
- Saul Griffith's sobering and very smart [Climate Change Recalculated](#) presentation depicts the challenge of the scale of infrastructure reorganization required to stymie the climate change snowball. Highly recommended.