“Energy Aware” Devices:

The Future of Device-Level Energy Reporting

Steven Beletich

2016 Australian Summer Study on Energy Productivity

Sydney, 24 – 26 February 2016

Beletich Associates
energy consultants

Genesis of Energy Aware Devices

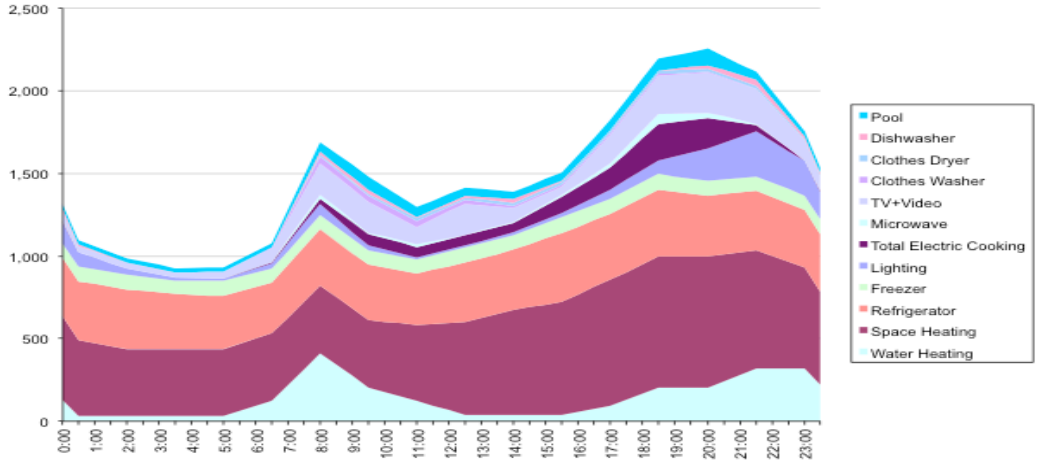
- “Internet of Things” is coming
- Network-connected devices communicate
- Could communicate their power/energy
- Energy transparency compels efficient devices?

Beletich Associates
energy consultants


Power.Meter
Wahman
4996 Hz
2.900 W
2498 V 2283 mA

Device-Level Energy Consumption Info is Useful

- For consumers – where is energy being consumed?
- For Home Energy Management systems

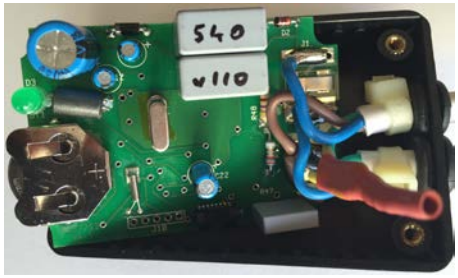


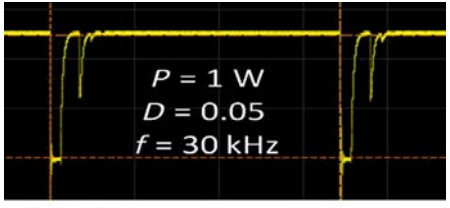
- For Smart Buildings
- For Smart Grids
- For “Intelligent Efficiency”
- For utilities / programs
- For policy-makers

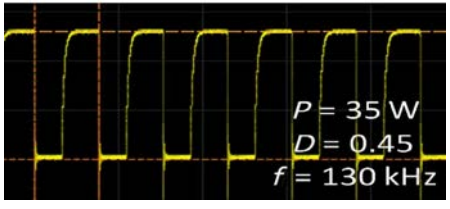
Beletich Associates
energy consultants

But….

- Measuring electrical power requires dedicated hardware
  - ~ several $
- Power monitoring chip
  - ~$1
- Modify switch-mode power supplies to measure power throughput [1]
  - ~10c







Lanzisera et al, http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=6778069

Alternatively…. Estimate Energy

- "External" estimation e.g. meter data

  …or…

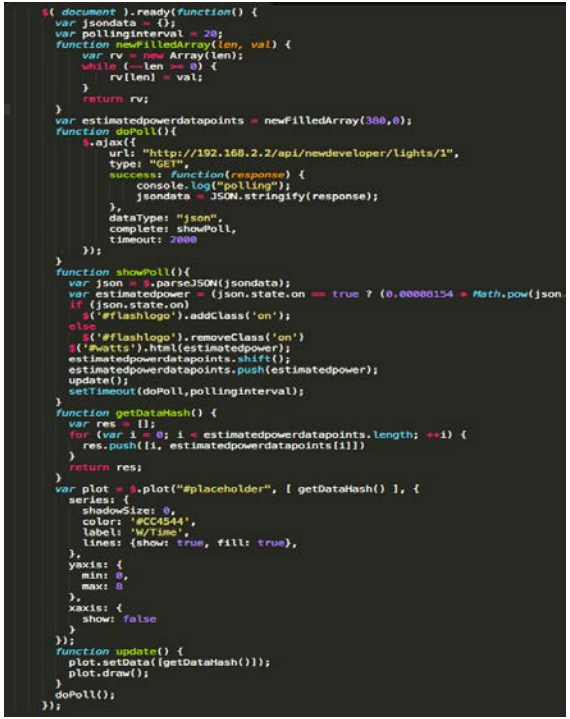
- "Native" estimation inside devices
  - Most devices controlled by a digital brain
  - Have enough knowledge to estimate energy
  - **= "Energy aware" devices**

Beletich Associates
energy consultants

Prototype: Energy Aware Lamp

Energy Aware Lamp [2]

- Very low cost
  - Devise power algorithm
  - Build into lamp
- Total development time ~1 day
- Accurate to ~0.1W

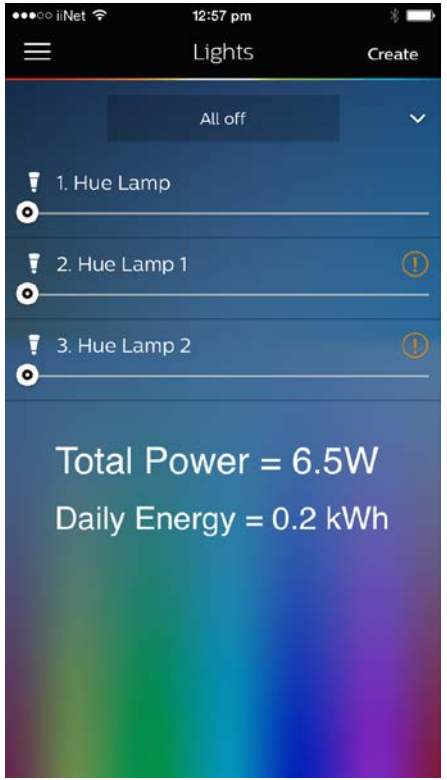


```
$( document ).ready(function() {
  var jsondata = {};
  var pollinginterval = 20;
  function newFilledArray(len, val) {
      var rv = new Array(len);
      while (--len >= 0) {
          rv[len] = val;
      }
      return rv;
  }
  var estimatedpowerdatapoints = newFilledArray(380,0);
  function doPoll(){
      $.ajax({
          url: "http://192.168.2.2/api/newdeveloper/lights/1",
          type: "GET",
          success: function(response) {
              console.log("polling");
              jsondata = JSON.stringify(response);
          },
          dataType: "json",
          complete: showPoll,
          timeout: 2000
      });
  }
  function showPoll(){
    var json = $.parseJSON(jsondata);
    var estimatedpower = (json.state.on == true ? (0.00008154 * Math.pow(json.
    if (json.state.on)
      $('#flashlogo').addClass('on');
    else
      $('#flashlogo').removeClass('on')
    $('#watts').html(estimatedpower);
    estimatedpowerdatapoints.shift();
    estimatedpowerdatapoints.push(estimatedpower);
    update();
    setTimeout(doPoll,pollinginterval);
  }
  function getDataHash() {
    var res = [];
    for (var i = 0; i < estimatedpowerdatapoints.length; ++i) {
      res.push([i, estimatedpowerdatapoints[i]])
    }
    return res;
  }
  var plot = $.plot("#placeholder", [ getDataHash() ], {
    series: {
      shadowSize: 0,
      color: '#CC4544',
      label: 'W/Time',
      lines: {show: true, fill: true},
    },
    yaxis: {
      min: 0,
      max: 8
    },
    xaxis: {
      show: false
    }
  });
  function update() {
    plot.setData([getDataHash()]);
    plot.draw();
  }
  doPoll();
});
```

Beletich Associates
energy consultants

Display Power / Energy

- On central server / cloud
- On browser, phone, etc.
- On TV screen
- On inbuilt LCD screen
  - (for non-networked devices)



Beletich Associates
energy consultants

Analogy: Vehicle Fuel Economy Display

- Now ubiquitous
- Is an estimate
- Zero marginal cost

Beletich Associates
energy consultants

Other Benefits

- Easy to check test
  - Only need to measure power, not output
  - Attach a power meter
- Self-measure energy savings – e.g. white certs
- Deter “cheating”
  - Logging energy will help identify cheating

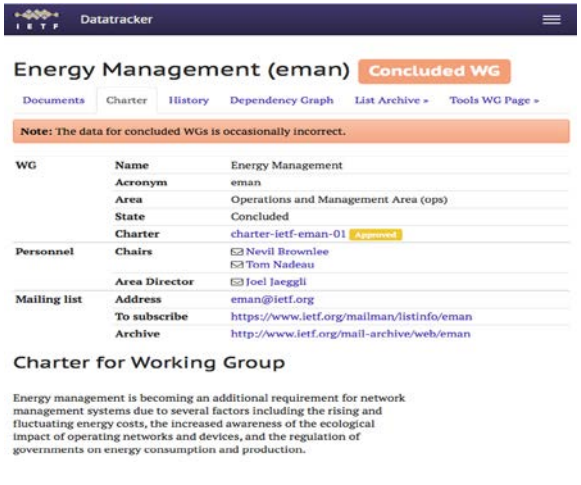
Beletich Associates
energy consultants

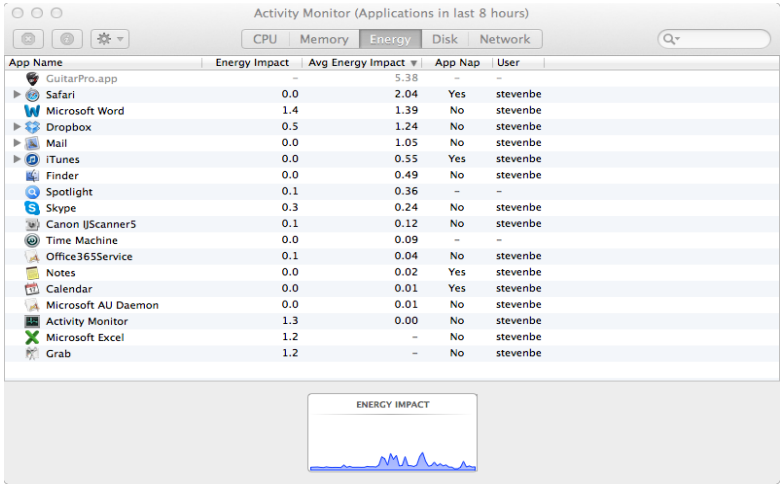
Need to be Careful of ….

- Privacy
- Increased energy to implement
- Information must be actionable

Beletich Associates
energy consultants

Related Initiatives





Beletich Associates
energy consultants

Energy Star Lamps 2.0

- Released 1 January 2016

12.9. Energy Consumption Reporting

The lamp, or the gateway device or cloud service connected to it, shall be capable of interconnecting with consumer authorized entities to communicate data representative of its interval energy consumption. It is recommended that data be reported in watt-hours for intervals of 15 minutes; however, representative data may also be reported in alternate units and intervals as specified in the product manufacturer's interface specification or API. If the lamp does not provide power consumption directly in watts, the manufacturer shall make available a method for estimating power consumption, in watts, from the representative data that is provided by the lamp.

Beletich Associates
energy consultants

In Summary,
Energy Aware Devices Could…

- Compel efficient device design
- Hold benefits for consumers, utilities, policy makers, etc.
- Be implemented at **zero marginal cost**

Beletich Associates
energy consultants

More Information

- http://edna.iea-4e.org
- http://cda.iea-4e.org
- steve@beletich.com.au

Beletich Associates
energy consultants