Systematic Literature Review

Done on IEEE with query

**Query:**

("Document Title":"Energy" AND ("Document Title": "consumption" OR "Document Title": "performance" OR "Document Title": "efficiency") AND (("All Metadata":"software") OR ("All Metadata":"programs") OR ("All Metadata":"programming") OR ("All Metadata":"programming languages") OR ("All Metadata":"framework")) AND ("All Metadata":"benchmark" OR "All Metadata":"Benchmarking"))

Years: 2016-2022

Only papers

60 papers

**Paper1: How Programming Languages and Paradigms Affect Performance and Energy in Multithreaded Applications**

**Benchmarks:** NAS Parallel Benchmark a well-known suite used for evaluation of parallel computers and applications. It is in C language

**Benchmarks used in paper:** *Fourier Transformation* (FT), *Integer Sort* (IS), *Conjugate Gradient* (CG), *Low-Upper* (LU)

**Ramark:** Benchmarks available in C but in paper they also use them in Java which are no longer available.

* Found possible NAS Parallel Benchmark on: <https://github.com/cwang9208/NPB>

as open source on github.

**Energy measured tool:** RAPL

**Context:** concurrent models

**Paper2: Understanding the Energy, Performance, and Programming Effort Trade-offs of Android Persistence Frameworks**

**OS:** Android

**Benchmarks:** DaCapo benchmarks

**Benchmarks used:** DaCapo H2 database benchmark developed in Java

**Context:** Database

* One Open source on github: <https://github.com/dacapobench/dacapobench>
* Same open source on gitlab: <https://gitlab.anu.edu.au/dacapo/anu-dev/dacapobench/-/tree/ac7322d853b85a1555bf8d8677bb560d508d3eac>
* Code use for experiments: All the code used in our experiments can be downloaded from <https://github.com/AmberPoo1/PEPBench>

**Remark:** H2 adapted to SQL Lite

**Tool for measuring energy:** Monsoon Power Monitor

**Paper3: Characterizing Hadoop Applications on Microservers for Performance and Energy Efficiency Optimizations**

**Benchmarks:** Hadoop micro-benchmarks.

**Benchmarks (more precise):** micro-benchmarks including WordCount, Sort, Grep and TeraSort on Hadoop

* List of hadoop benchmarks: <https://nbhat-technical.blogspot.com/2018/03/benchmarking-bigdata.html>

**Context:** Measured performance of Hadoop MapReduce -> Concurrent models (parallelisme)

**Tool to measure energy:** Perf

**Paper4: Performance, Power, and Energy-Efficiency Impact Analysis of Compiler Optimizations on the SPEC CPU 2017 Benchmark Suite**

**Benchmarks:** SPEC CPU 2017 benchmark suite with 43 benchmarks from different domains, including integer and floating-point heavy computations on a state-of-the-art server system for cloud applications

* SPECrate 2017 Integer, 10 benchmarks
* SPECrate 2017 Floating Point, 13 benchmarks
* SPECspeed 2017 Integer, 10 benchmarks
* SPECspeed 2017 Floating Point, 10 benchmarks

**Benchmarks (cost):** On official website needs payment (high cost)

**Context:** Simple programs (no multi-threading)

**Languages:** C, C++, and Fortran

**Tool to measure energy:** path profiling technique (Didn’t find tool)

**Paper5: Semidefinite Programming based Resource Allocation for Energy Consumption Minimization in Software Defined Wireless Sensor Networks**

Not what is needed!

**Paper6: On the Performance and Energy Efficiency of the PGAS Programming Model on Multicore Architectures**

**Benchmarks:** NAS Parallel Benchmarks to evaluate the performance and energy efficiency of the UPC programming language

**Selected benchmarks:** Integer Sort (IS), Conjugate Gradient (CG), Multi- Grid (MG), and Fourier Transformation (FT).

* Found possible NAS Parallel Benchmark on: <https://github.com/cwang9208/NPB>

as open source on github.

**Remark:** Same benchmark as for paper1

**Tools for energy:**

* High definition Energy Efficiency Monitoring tool in order to measure energy. HDEEM is a hardware based solution for energy measurements, meaning that additional hardware is used to measure energy in a supercomputer

* Intel Performance Counter Monitor

**Context:** concurrent models

**Paper7: Towards New Metrics for Appraising Performance and Energy Efficiency of Parallel Scientific Programs**

**Benchmarks:** PARSEC benchmark

* blackscholes
* bodytrack
* canneal
* dedup
* facsim
* ferret
* fluidanimate
* freqmine
* streamcluster
* swaptions
* vips
* x264

Can be found: <https://github.com/bamos/parsec-benchmark>

Also here: <https://github.com/cirosantilli/parsec-benchmark>

**Context:** Concurrent models (multithreading)

**Tool to measure energy:** RAPL

**Paper8: Artifacts for “A Comprehensive Study on the Energy Efficiency of Java’s Thread-Safe Collections”**

**Tool to measure energy:** jRAPL

**Benchmarks:** ? (Not found because website of source code not available and no mention of which exactly benchmark, except mention that they used micro benchmark)

**Paper9: Evaluation of Energetic Efficiency of the Industrial Systems by using Benchmark Energy Factor**

**Benchmarks:** The paper proposes a new concept of using of Mathematical Model Benchmarking (MMB)

**Remark: Not what is needed!**

**Paper10: Performance and Energy Consumption Analysis of Coprocessors using Different Programming Models**

**Benchmarks:** Linpack and HPL 2.1 benchmarks

Linpack benchmark for shared memory machines and the HPL 2.1 for distributed memory environments.

* Source of benchmark: <http://www.netlib.org/benchmark/hpl/>

**Tool to measure energy:** RAPL

**Paper11: Business Benchmarking of Global Operations: The Case of Water and Energy Consumption in the Brewery Industry**

**Remark: Paper related to engineering field and not computer science!**

**Paper12: A Sectorial Decision Support Model for Energy Consumption Reduction in Manufacturing SMEs**

**Remark: Not related to computer science! No benchmarks also!**

**Paper13: Energy, Power, and Performance Characterization of GPGPU Benchmark Programs**

**Benchmarks:** 34 programs from 5 GPGPU benchmark suites

* LonestarGPU: <https://iss.oden.utexas.edu/?p=projects/galois/lonestargpu>
* Parboil: <http://impact.crhc.illinois.edu/parboil/parboil.aspx>
* Rodinia: <http://www.cs.virginia.edu/rodinia/doku.php>
* SHOC: <https://github.com/vetter/shoc>
* CUDA-SDK (some codes): Maybe here: <https://developer.nvidia.com/cuda-code-samples>

**Tool for measuring energy:** digital multimeter

**Context:** GPU performance

**Paper14: Benchmarking the Performance and Energy Efficiency of AI Accelerators for AI Training**

**Benchmarks:** AI Benchmarks:

* MLPerf
* DAWNBench
* AIBench
* Fathom
* TBD

**Tools to measure energy:** NVIDIA Management Library [36] on NVIDIA GPUs and

ROCm System Management Library [11] on the AMD GPU.

For CPU measure:?

**Context:** Deep learning (more GPU) and multithreading

**Paper15: MofySim: A Mobile Full-System Simulation Framework for Energy Consumption and Performance Analysis**

**Benchmarks:** SPEC CPU2006 benchmarks, mobile benchmark applications such as *BBench* [8], *MobileBench* [9], and *Moby*

**Tools:** Wattch, SoftWatt

**Context:** Mobile, CPU in mobile

**Paper16: Native or Web? A Preliminary Study on the Energy Consumption of Android Development Models**

**OS:** Android

**Benchmarks:** Rosetta Code, The Computer Language Benchmark Game

* Rosetta Code (Benchmarks or Apps): SeqNonSquares, Perfect Number, HofstadterQ, Zero-One Knapsack, Knapsack Unbounded, nQueens, MergeSort, Matrix Multiplication, GnomeSort, Sieve of Eratosthenes, Man or Boy, BubbleSort, CountingSort, QuickSort, Knapsack Bounded, Happy Numbers, HeapSort, InsertSort, Tower of Hanoi, Count in factors, Combinations, PancakeSort and ShellSort
* Rosetta code: <http://www.rosettacode.org/wiki/Rosetta_Code>
* Computer Language Benchmark Game: BinaryTree, Fannkuch, Fasta S.Core, Fasta M.Core, Nbody, Spectral, RegenDna S.Core, RegenDna M.Core, RevComp and Knucleotide
* F-Droid: anDOF and Tri Rose

**Languages:** Java and JavaScript

**Tool for measuring energy:** All data about energy consumption was collected using Project Volta (​​Android’s Project Volta)

**Paper17: MIPP: A Microbenchmark Suite for Performance, Power, and Energy Consumption Characterization of GPU architectures**

**Benchmarks:** They developed benchmark but no much information on it.

**Tool to measure energy:** CUDA nvprof, AMD APP

**Paper18: An Experimental Analysis of PaaS Users Parameters on Applications Energy Consumption**

**Benchmarks:** RUBiS Benchmark, a web application benchmark

* Rubis: <http://kcsrk.info/Quelea/rubis-test.html>
* Rubis (github a bit modified): https://github.com/uillianluiz/RUBiS

**Context:** database

**OS:** cloud servers, web server

**Tools:** power meters plugged to the servers (not profilers)

**Paper19: A Comprehensive Study on the Energy Efficiency of Java’s Thread-Safe Collections**

**Benchmarks:** The benchmarks used in this study consist of 16 commonly used collections (13 thread-safe, 3 non-thread-safe) available in the Java programming language

* Lists (java.util.List)
  + Iterator
  + ArrayList
  + Vector
  + Collections.synchronizedList()
  + CopyOnWriteArrayList
* Maps (java.util.Map)
  + LinkedHashMap
  + Hashtable
  + Collections.synchronizedMap()
  + ConcurrentSkipListMap
  + ConcurrentHashMap
  + ConcurrentHashMapV8
* Sets (java.util.Set)
  + LinkedHashSet
  + Collections.synchronizedSet()
  + ConcurrentSkipListSet
  + ConcurrentHashSet
  + CopyOnWriteArraySet
  + ConcurrentHashSetV8

**Tool measure energy:** jRAPL

**Paper20: Metaheuristics for Energy-Efficient No-Wait Flowshops: A Trade-off Between Makespan and Total Energy Consumption**

**Not Computer Science!**

**Paper21: Energy-Efficiency Optimization of UAV-Assisted Internet of Things**

**Benchmarks:** No exactly benchmarks mentioned

**Paper not really related to our subject**

**Paper22: Speedup and Parallelization Models for Energy-Efficient Many-Core Systems Using Performance Counters**

**Benchmarks:** PARSEC benchmarks (same as in paper7)

* Can be found: <https://github.com/bamos/parsec-benchmark>
* Also here: <https://github.com/cirosantilli/parsec-benchmark>

**Context:** parallelization

**Tools:** PWR PKG ENERGY

**Paper23: Energy Consumption Analysis of Java Command-line Options**

**Benchmarks:** SPECjvm2008 benchmarks

Analysis of Java command line options: client, server, Xbatch, Xcomp, Xfuture, Xint, Xmixed, Xrs, AggressiveOpts, AggressiveHeap, Inline, AlwaysPreTouch, Xnoclassgc, UseSerialGC, UseParallelGC, UseConcMarkSweepGC, and UseG1GC

**Energy measured with:** RAPL (mentioned), perf used

**OS:** Ubuntu

**Paper24: Improving Energy Efficiency of Field-Coupled Nanocomputing Circuits by Evolutionary Synthesis**

Not right paper!

**Paper25: On the Runtime and Energy Performance of WebAssembly**

**Benchmarks:** Rosetta Code and CLBG, WASM

* WASM: <https://github.com/greensoftwarelab/WasmBenchmarks>
* Rosetta code: <http://www.rosettacode.org/wiki/Rosetta_Code>
* CLBG

**Tools:** RAPL

**Languages:** C and Javascript

**Paper26: A Study on the Energy Consumption of Android App Development Approaches**

**Benchmarks:** Rosetta Code and CLBG, FDroid

**Tools:** Project Volta

**OS:** Android

**Paper27: Raspberry Pi 2 B+ GPU Power, Performance, and Energy Implications**

**Benchmarks:** omxplayer, mplayer, vlc, 3D-slash

**Tools:** Perf

**System monitor:** Top

**Paper28: Energy Efficiency and Performance of Auto-Vectorized Loops on Intel Xeon processors**

**Benchmarks:** Extended Test Suite for Vectorizing Compilers (ETSVC) as a benchmark

**Tool:** RAPL

**Type of research:** Compilers

**Paper29: A Comparison of Evolutionary Techniques for Task- To-Core Scheduling Algorithms with Performance, Energy, and Temperature Optimization**

**Benchmarks:** Fast Fourier Transform (FFT), Gauss Elimination and Laplace Equation

**Tool:** ?

**Paper30: Comparing Energy Efficiency of CPU, GPU and FPGA Implementations for Vision Kernels**

**Benchmarks (as libraries):** OpenCV, Nvidia VisionWorks and Xilinx xfOpenCV

* Here: <https://github.com/isu-rcl/cvBench>

**Tool:** ?

**Paper31: Distance and Energy Consumption Minimization in Electric Traveling Salesman Problem with Time Windows**

**Benchmarks:** The Traveling Salesman Problem with Time Windows (TSPTW)

* Here: <https://homepages.dcc.ufmg.br/~rfsilva/tsptw/>
* Additional source: <https://myweb.uiowa.edu/bthoa/tsptwbenchmarkdatasets.htm>

**Tool:** Not mentioned

**Context:** Study of TSP problem (optimization problem)

**Languages used:** C++

**Components:** Intel Core i5 processor at 2.50 GHz and 8 GBs of RAM

**Paper32: Quantifying the Performance and Energy-Efficiency Impact of Hardware Transactional Memory on Scientific Applications on Large-Scale NUMA Systems**

**Benchmarks:** CLOMP-TM benchmark, which is a highly-configurable synthetic benchmark that emulates the runtime behaviors of various scientific workloads

**Description of benchmark:**

The CLOMP-TM benchmark: It is a synthetic bench- mark that emulates the memory access and synchroniza- tion behaviors of scientific applications [4, 22]. It is fully configurable in terms of the thread count, synchroniza- tion primitives (i.e., locks, transactions), synchronization granularity (i.e., fine-grain, coarse-grain), contention level, computation-to-synchronization ratio, and so on.

**Remark:** CLOMP-TM is one benchmark. Here: <http://www.eurotm.org/tmbenchmarks>

we can find more of TM benchmarks

**More benchmarks:** two scientific benchmarks genome and fluidanimate

* Genome: C. C. Minh et al. “STAMP: Stanford Transactional Applications for Multi-  
  Processing”. In: IISWC ’08. 2008.
* Fluidanimate: G. Kestor et al. “RMS-TM: A Comprehensive Benchmark Suite for Transactional Memory Systems”. In: ICPE ’11. 2011.

**Tool:** Not mentioned

**Context:** Parallelism

**OS:** Linux

**Paper33: IACM: Integrated Adaptive Cache Management for High-Performance and Energy-Efficient GPGPU Computing**

**Benchmarks: Rodinia, CUDA-samples, SHOC**

* Rodinia: <https://github.com/yuhc/gpu-rodinia> , <http://www.cs.virginia.edu/rodinia/doku.php>
* CUDA-SDK (some codes): Maybe here: <https://developer.nvidia.com/cuda-code-samples>
* SHOC: <https://github.com/vetter/shoc>
* MAPReduce: B. He et al. “Mars: A MapReduce Framework on Graphics Processors”. In: PACT ’08. 2008.

**Tools:** GPUWattch

**Context:** GPGPU computing

**Paper34: Exploring GPU performance, power and energy-efficiency bounds with Cache-aware Roofline Modeling**

**Benchmarks:** GPU micro-benchmarking

* Parboil: <http://impact.crhc.illinois.edu/parboil/parboil.aspx>
* SHOC: <https://github.com/vetter/shoc>
* Rodinia:<https://github.com/yuhc/gpu-rodinia> , <http://www.cs.virginia.edu/rodinia/doku.php>
* Polybench: <https://github.com/MatthiasJReisinger/PolyBenchC-4.2.1>
* NVIDIA benchmarks (maybe): <https://developer.nvidia.com/cuda-code-samples>
* Libraries (cuBLAS, cuFFT and BlackScholes)

**Tools:** Not found

**Context:** GPU computing

**Paper35: Energy Consumption Optimization of the Total-FETI Solver and BLAS Routines by Changing the CPU Frequency**

**Bad document (Only abstract and no benchmarks)**

**Paper36: Power-capping Aware Checkpointing: On the Interplay among Power-capping, Temperature, Reliability, Performance, and Energy**

**Benchmarks: Rodinia benchmark suite and NPB benchmark**

* Rodinia:<https://github.com/yuhc/gpu-rodinia> , <http://www.cs.virginia.edu/rodinia/doku.php>
* NPB:<https://github.com/cwang9208/NPB> as open source on github.

**Tools:** Librapl and Intel Power Governor (CPU power consumption)

**Tools (mentioned):** TAU profiling tool [22] and PAPI counters

**OS:** Linux

**Context:** Parallelization (concurrency)

**Paper37: Harnessing Voltage Margins for Energy Efficiency in Multicore CPUs**

**Benchmarks:** SPEC CPU2006 benchmarks

**Tools:** no profilers found

**OS:** Linux

**Context:** Not clear, test chips maybe concurrency

**Paper38: Understanding the Role of Memory Subsystem on Performance and Energy-Efficiency of Hadoop Applications**

**Benchmarks:** SPEC CPU2006 benchmarks

**Tools:** Intel Performance Counter Monitoring tool (PCM)

**Context:** Parallelization in Spark

**OS:** Linux Ubuntu

**Paper39: Predicting the Energy Consumption of MPI Applications at Scale Using a Single Node**

**Benchmarks:** MPI NAS Parallel Benchmark Suite, NAS-EP benchmark and NAS-LU benchmark

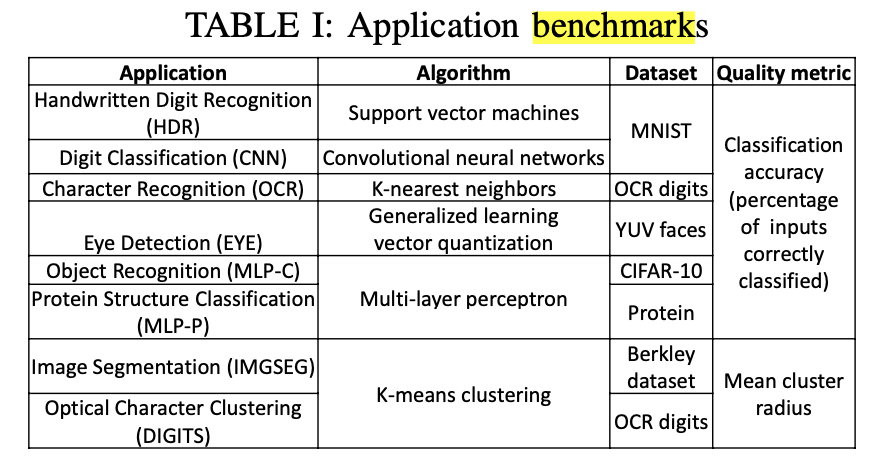
* NPB:<https://github.com/cwang9208/NPB> as open source on github.

**Tools:** Grid’5000 API (powermetter, not sure)

**Context:** Parallelization

**Paper40: Approximate Memory Compression for Energy-efficiency**

**Benchmarks:** ML oriented benchmarks



**Tools:** Outside measurement tool

**Context:** Memory measurement (DRAM), ML

**Paper41: Evaluating and Improving the Energy Performance of School Buildings with a Proposed Real-Time Monitoring System**

**Not related to Computer Science**

**Paper42: User-Centric Energy Efficiency of Distributed Antenna Systems with Wireless Power Transfer**

**Not relevant, no really benchmarks of CS.**

**Paper43: A Statistical Analysis of Performance in the 2021 CEC-GECCO-PESGM Competition on Evolutionary Computation in the Energy Domain**

**No benchmarks**

**Paper44: Performance and Energy Analysis of OpenMP Runtime Systems with Dense Linear Algebra Algorithms**

**Benchmarks:** KASTORS benchmark suite and an OpenMP-parallelized PLASMA version

* Kastors benchmark: <https://gitlab.inria.fr/openmp/kastors>

**Tools:** RAPL

**Context:** Linear Algebra Algorithms

**Paper45: Roofline Model Based Performance-Aware Energy Management for Scientific Computing**

**Benchmarks:** NAS Parallel Benchmark(NPB), UGKS, and CFD software Fluent

* NPB: <https://github.com/cwang9208/NPB> as open source on github.

**Tools:** RAPL, Watts Up Pro Portable Power Meter

**Description tool (2):**

Watts Up Pro Portable Power Meter is used to measure the node level power and energy. Running Average Power Limit (RAPL) interface is used to get the fine-grained power such as CPU power, memory power.

**Context:** Parallelization (bc NPB benchmark)

**Paper46: PERFORMANCE ASSESSMENT OF DYNAMIC ANALYSIS BASED ENERGY ESTIMATION TOOLS**

**Benchmarks:** NativeWhetstone2, LinpackSP2, LivermoreLoops2, and FFT1 benchmark applications

**Tools:** Power Tutor and Trepn Profiler dynamic energy estimation tools

**OS:** smartphone ARM-7

**Context:** analysis based energy estimation for smartphone applications

**Paper47: Airavat: Improving Energy Efficiency of Heterogeneous Applications**

**Benchmarks:** the *Gene Alignment (GA)* and the *Stream Compaction (SC)* from the Hetero-Mark and Chai benchmark suite

* Benchmarks and additional (interesting) benchmarks: <https://github.com/NUCAR-DEV/Hetero-Mark>

**Tools:** built-in INA power monitors

**Context:** performance of graphic card

**OS:** NVIDIA Jetson TXl

**Paper48: Joint Optimization of Execution Latency and Energy Consumption for Mobile Edge Computing with Data Compression and Task Allocation**

**Benchmarks: No benchmarks**

**Context:** Networking

**Tools:** no

**Paper49: Analysis of the practical implementation of Energy Performance Certificate for Buildings of Academic Institution in South Africa**

**Not Computer Science**

**Paper50: New Algorithms for Maximizing Cellular Wireless Network Energy Efficiency**

**No benchmarks and not relevant paper**

**Paper51: Energy and Runtime Performance Optimization of Node.js Web Requests**

**Benchmarks:** Web-Server CPU Frequency Aware Benchmark Suite

The benchmark simulates a real-world Node.js web ap- plication. It is necessary to build a benchmark that utilizes technologies, modules, architectural features and tasks- scenarios found in industry to determine the CPU frequency impact on web applications.

Benchmark build by authors (DIDN’T FIND)

**Tools:** RAPL

**Context:** Web consumption

**Paper52: Optimizing the Energy Consumption of Neural Networks**

**Benchmarks:** GTSRB dataset as benchmark

From paper: J.Stallkamp,M.Schlipsing,J.Salmen,andC.Igel,“TheGermanTraffic Sign Recognition Benchmark: A multi-class classification competition,” in *IEEE International Joint Conference on Neural Networks*, 2011, pp. 1453–1460.

* Dataset: <https://benchmark.ini.rub.de/gtsrb_dataset.html> (check also for code?)

**Tools:** No found

**Context:** Evaluation of energy of GTSRB dataset

**Paper53: Design of Synchronous Reluctance Motors with IE4 Energy Efficiency Standard Competitive to BLDC Motors used for Blowers in Air Conditioners**

**Benchmarks:** benchmark BLDC ( Not really want we want)

**Not relevant paper**

**Paper54: The Impact of Turbo Frequency on the Energy, Performance, and Aging of Parallel Applications**

**Benchmarks:** Linpack benchmark, Open Multi-Processing, NAS Parallel benchmark, Rodinia Benchmark Suite

Seven applications from different domains: fast Fourier transform (FFT) [24]; the high performance conjugate gradient (HPCG) benchmark [25]; Jacobi Iteration Method (JA) [26]; Liver- more unstructured Lagrangian explicit shock hydrodynamics (LULESH2) [27]; n-body (NB) [26]; Poisson (PO) [26]; and STREAM (ST) [28]

**Tools:** Application Power Management library, Linux monitoring sensors to get the current CPU temperature/second

**OS:** Ubuntu

**Context:** Parallelization

**Paper55: Automatic Energy-Efficiency Monitoring of OpenMP Workloads**

**Benchmarks:** Rodinia benchmark

**Tools:** PAPI [4] or scorep [12] can be used to gather the performance and power consumption numbers of a system.

**Context:** HPC, parallelization

**Paper56: A Heterogeneous Dynamic Scheduling Minimized Make-span For Energy and Performance Balancing**

**Benchmarks:** Montage scientific benchmark: <http://montage.ipac.caltech.edu/docs/grid.html>

**Tools:** CloudSim?

**Context:** Cloud computing (parallelization)

**Paper57: Optimal Precoder Designs for Energy-Efficiency Maximization in Secure MIMO Systems**

**Benchmarks:** No mentioned much of benchmarks

**Paper58: Energy Consumption Optimal Design of Power Grid Inspection Trajectory for UAV Mobile Edge Computing Node**

**Benchmarks: Not found**

**Paper59: A Non-Cooperative Data Center Energy Consumption Optimization Strategy Based on SDN Structure**

**Not relevant**

**paper60: F1: Striking the Balance Between Energy Efficiency & Flexibility: General-Purpose vs Special-Purpose ML Processors**

**not relevant**

**paper61: Performance Analysis of a Blockchain Based Peer-to-Peer Energy Trading Framework**

Not relevant