Green-ILC AAA-2014 Report

Advanced Accelerator Association Promoting Science & Technology

2014 AAA Green-ILC Working Group

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English Version

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1 Introduction

The total electrical power consumption of the International Linear Collider (ILC) reaches 164MW at 500GeV center-of-mass energy. With 106MW the two main linacs are the most consuming components where 49% is used by the RF system, 30% by the helium refrigerator and 20% by the remaining equipment (air conditioning, water cooling, lighting, and control racks). The Green-ILC (G-ILC) project focuses mainly on new technologies and approaches to save, recover and recycle energy as well as on the use of renewable energy for particle colliders.

The main linac is simply the repetition of many merely identical cells (or cryomodules), then the optimization of the energy consumption and efficiency of this basic element directly improves the overall energy performance of the ILC. Increasing the efficiency reduces the power lost on heat waste which also, to be dissipated, consumes energy but it also reduces capital cost when fewer parts are needed to provide the same output power.

Large scale research infrastructures like the ILC have major impacts on the environment in terms of electrical power supply, heat waste recycling, water management, landscape integration and road traffic. G-ILC intends to make ILC a world-wide reference on handling these issues to the best benefit of the local people and of the society.

After colliding, both beams must be recycled or actually simply dump as in the current design. In total, 10MW released in 1ms short pulse at a 5 Hz rate must be absorbed. G-ILC will address conventional and advanced technologies to recover and recycle this energy keeping the produced radioactive elements at minimum.

ILC as a large energy consumer similar to big factories, data centers or medium cities must work towards sustainability to curb carbon emission and global heating. G-ILC will study the use of renewable energies in its energy mix focusing on production, storage and transport (smart grid).

Energy is one of the most prominent concerns of the 21st century and a global endeavor backed both by the private and public sectors. G-ILC addresses the same issues in a basic research framework which has proved to be innovative and able to manage large industrial programs. With a deep cooperation with the high-tech industry and energy experts, solutions will be found and tested and then transferred to the society.

The Technical Group of the Advanced Accelerator Association Promoting Science and Technology formed the Green ILC working group with the fact-finding mission to bring energy-saving technology to the ILC accelerator. Getting together the technical capabilities of cutting-edge companies, accelerator and experimental researchers, we propose to incorporate energy-saving technology to an advanced accelerator such as ILC.

This report is a collection of presentations given during meetings held in 2014/15. It is a first step towards greening the ILC.

Green-ILC WG Chair: Takayuki Saeki
AAA Technology Study Group Chair: Hitoshi Hayano

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Green-ILC Working Group

Green-ILC Working Group

To reduce the environment and social impacts as well as the operating cost of a large scale advanced accelerator, energy saving and high efficiency component are required from the design stage to the operation. In addition, the integration of renewable energy in the ILC mix is a necessary step to reach sustainability. The "Green ILC Working Group" set as part of the technical group has been created to cover these issues.

The suggestions from AAA technology studies in the 2014 fiscal year have also been included. The activities are summarized in the following table.

Green ILC・WG	Date	Green technology proposer and Technology presenter (affiliation, w/o title)
1-st	2014-2-25	Denis Perret-Gallix(LAPP/IN2P3/CNRS), Junpei Fujimoto(KEK), Atsuto Suzuki(KEK)
2-nd	2014-5-8	Yoshio Kawakami(Toshiba electron tube), Masato Noguchi(Maekawa), Tadashi Fujinawa(Riken), Junichi Honda(Solar power association), Mitsuo Takeda(Kabuki)
3-rd	2014-7-1	Junpei Fujimoto(KEK), Ken Watanabe(KEK), Hiroyuki Nishi(Shinnihon-Kucho), Tadashi Fujinawa(Riken), Denis Perret-Gallix(LAPP)

4-th	2014-9-24	Tadashi Fujinawa(Riken), Osamu Takehisa(NTT facilities), Takafumi Shimokouchi(Takenaka), Takayuki Saeki(KEK)
5-th	2014-12-10	Toru Shibagaki(Toshiba), Hajime Sakuma(NEC), Kentaro Otsuki(Tohoku Electric), Denis Perret-Gallix(LAPP), Takayuki Saeki(KEK)
6-th	2015-2-18	Kunihito Kikuchi(Fujikura), Naoko Nakamura(Maekawa), Manabu Miyamoto(MHI), Mitsuhiro Yoshida(KEK), Takayuki Saeki(KEK)

The presentations can be broadly organized in 4 sections: energy saving technology (10), energy recovery technology (2), storage technology of recovering energy (4), implementation of renewable energy (8). They are summarized in details in the following table. It should be noted, the energy-saving technologies presented during the 34th Technology Study meeting are also included.

Technology	**Sub-system**	**Report Title (concise)**	**Presenter (w/o title)**	**Affiliation (concise)**	**Meeting**
Power saving	RF System	CPD Klystron	Kawakami	Toshiba	G-ILC
		CPD Klystron Test	Watanabe	KEK	G-ILC
		Power Electronics	Yamada	Mitsubishi Electric	Technolog y Study
	Cryogenics	Helium compressor power saving	Noguchi	Maekawa	G-ILC
		HTS cryogenics	Nakamura	Maekawa	G-ILC
	Infra-structure	Friction reduction chemicals	Nishi	Shin-Nihon Kucho	G-ILC
		High-voltage Substation power saving	Fujinawa	Riken	G-ILC
		Data center power saving	Takehisa	NTT Facilities	G-ILC
		YBCO HTS cable	Kikuchi	Fujikura	G-ILC
		Smart Community	Shimokouchi	Takenaka	G-ILC
Energy recovery	Beam Dump	Energy recovery from beam dump	Fujimoto	KEK	G-ILC
		Related Beam experiments	Yoshida	KEK	G-ILC
Energy storage	Energy management	Co-generation	Osaki	MHI	Technolog y Study

		Iron energy storage	Hosoyama	KEK	Technology Study
		Power storage for power line	Sakuma	NEC	G-ILC
		Energy management	Miyamoto	MHI	G-ILC
Renewable Energy		Accelerator power saving	Suzuki	KEK	Technology Study
		New Energy Power Plants	Fujinawa	Riken	G-ILC
		LN2 Economy	Perret-Gallix	LAPP/IN2P3	G-ILC
		Green-ILC	Perret-Gallix	LAPP/IN2P3	G-ILC
		Renewable Energies and Environment	Perret-Gallix	LAPP/IN2p3	G-ILC
	Solar Power	Solar power generation	Honda	Solar Power Association	G-ILC
	Biomass Energy	Biomass power generation	Takeda	Kabuki	G-ILC
	Geo-thermal power	Geothermal power generation	Shibagaki	Toshiba	G-ILC
		Geothermal Power Station	Otuki	Tohoku Electric	G-ILC
	Wind Power	—			
	Marine power	—			

As a reference, find here the power consumptions computed for the ILC Technical Design Report (Vol 3.II, sec 11.4.4)*

Table 11.6
Estimated DKS power loads (MW) at 500 GeV centre-of-mass operation. 'Conventional' refers to power used for the utilities themselves. This includes water pumps and heating, ventilation and air conditioning, (HVAC). 'Emergency' power feeds utilities that must remain operational when main power is lost.

Accelerator section	RF Power	Racks	NC magnets	Cryo	Conventional		Total	
					Normal	Emergency		
e^- sources	1.28	0.09	0.73	0.80	1.47	0.50	4.87	
e^+ sources	1.39	0.09	4.94	0.59	1.83	0.48	9.32	
DR	8.67		2.97	1.45	1.93	0.70	15.72	
RTML	4.76	0.32	1.26		1.19	0.87	8.40	
Main Linac	52.13	4.66	0.91	32.00	12.10	4.30	106.10	
BDS			10.43	0.41	1.34	0.20	12.38	
Dumps					0.00	1.21	1.21	
IR			1.16	2.65	0.90	0.96	5.67	
TOTALS	68.2	5.2	22.4	37.9	20.8	9.2	164	MW
Rank:	1	6	3	2	4	5		
% :	42	3	15	23	13	5		

* http://edmsdirect.desy.de/edmsdirect/file.jsp?edmsid=D00000001021265&fileClass=native