PROPOSAL
Feasibility Study of Direct Conversion Nuclear Reactor Technologies

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This proposal includes a feasibility study of two Technologies, Heat-to-Light-to-Electricity Conversion (HLEC) and Thermophotovoltaic (TPV) conversion for use in the Direct Conversion Nuclear Reactors.

1. BACKGROUND

Development of a nuclear reactor system is a major endeavor typically undertaken by established corporations with existing infrastructure, expertise, and technological capabilities. A project requiring investment on the order of a billion dollars can only be justified if there is a proven and patented breakthrough technology promising superior efficiency and stellar safety in nuclear power generation. Even in such a case, collaboration with an established corporation operating in the nuclear field would be the optimal pathway to execution.

Recognizing these challenges, the present proposal does not seek to develop and manufacture a full-scale **Direct Conversion Small Modular Reactor (SMR)** at this stage. Instead, it focuses on conducting essential research to validate the feasibility of scaling two promising **Direct Heat-to-Electricity Conversion Technologies**—**Heat-to-Light-to-Electricity Conversion (HLEC)** and **Thermophotovoltaic (TPV) conversion**—to power production levels in the megawatt (MW) range.

2. PROJECT SCOPE AND OBJECTIVES

The present proposal seeks funding for a targeted **R&D project** to assess whether **HLEC and TPV** can be effectively scaled to produce **MW-level electric power** from nuclear reactors. This research will:

- **Analyze fundamental physics and material performance** required for high-efficiency conversion.
- **Conduct experimental validation** of power generation potential.
- **Evaluate scalability** from laboratory-scale testing to practical reactor integration.
- **Develop a conceptual design for a prototype Direct Conversion Reactor** at an SMR power level.

The project does **not** aim to develop a full commercial reactor but to determine whether HLEC and TPV technologies are viable alternatives to conventional steam-cycle electricity generation in nuclear systems.

3. COLLABORATIVE RESEARCH TEAM

This project is envisioned as a collaborative effort between a **US-based team of nuclear scientists and advanced material researchers** and **a team of scientists and engineers from Technion – Israel Institute of Technology**.

Technion's Role in the Collaboration

Technion is a world-leading Israeli hi-tech research institution with extensive expertise in:

- **Advanced materials science**, particularly high-temperature-resistant materials.
- **Photonics and nanotechnology**, which are critical for optimizing HLEC and TPV systems.

- **Nuclear and energy conversion research**, contributing theoretical and experimental insights into non-mechanical heat-to-electricity conversion.

The collaboration will enable an **international exchange of expertise**, leveraging Technion's specialization in **optical engineering and materials science** alongside **US-based nuclear engineering and reactor physics knowledge**.

4. SCOPE OF WORK, TIMELINE, AND BUDGET

Scope of Work

The project will be divided into the following key work packages:

Phase 1: Foundational Research (Year 1)

- **Thermal Radiation Analysis**: Define the most efficient spectral ranges for HLEC and TPV conversion.
- **Material Selection & Testing**: Identify and test radiation-resistant materials for high-temperature emitters and PV cells.
- **Computational Modeling**: Develop simulations for heat-to-light and light-to-electricity conversion efficiency.
- **Preliminary System Design**: Establish a conceptual model for power extraction at MW levels.

Phase 2: Experimental Validation (Years 2-3)

- **Prototype Thermal Emitters**: Construct and test selective emitters in nuclear-relevant conditions.
- **PV Cell Efficiency Optimization**: Assess performance of GaSb, GaAs, and novel PV materials.
- **Heat Transfer Mechanisms**: Optimize methods for coupling nuclear reactor heat to HLEC and TPV emitters.
- **Small-Scale Demonstrator**: Build a laboratory-scale testbed to validate conversion efficiency.

Phase 3: Feasibility of Scaling to MW Power (Years 4-5)

- **Long-Duration Testing**: Assess degradation, material stability, and efficiency over extended operation.
- **System Integration Modeling**: Simulate how an HLEC or TPV system would function in an SMR environment.
- **Conceptual Reactor Integration**: Develop preliminary designs for a Direct Conversion Reactor capable of producing **MW-scale power**.

5. PROJECT TEAM & REQUIRED EXPERTISE

Each team (US and Israeli) will consist of 4-5 members, including:

- **Nuclear Engineer (1)** – Reactor core thermal analysis and safety considerations.
- **Materials Scientist (1-2)** – High-temperature material selection and degradation studies.
- **Optical Physicist (1)** – Optimization of thermal emitters and photon transport.
- **Photonics Engineer (1)** – Development of advanced spectral filtering and optical coatings.
- **PV Specialist (1)** – Optimization of TPV cells for radiation capture efficiency.
- **Experimental Researcher (1)** – Overseeing laboratory testing of emitter-PV interactions.

Timeline & Budget (3-5 Years)

Phase	**Duration**	**Budget Estimate (USD)**
Phase 1: Foundational Research	12 months	$10M - $15M
Phase 2: Experimental Validation	24 months	$25M - $35M
Phase 3: Feasibility & Scaling	24 months	$15M - $25M
Total Estimated Budget	**3-5 years**	**$50M - $75M**

6. POTENTIAL FUNDING SOURCES

This project aligns with multiple US and international funding opportunities, including:

US-Based Funding Sources

- **Department of Energy (DOE) Advanced Research Projects Agency-Energy (ARPA-E)** – Supports high-risk, high-reward energy innovations.
- **DOE Office of Nuclear Energy** – Provides grants for next-generation nuclear technologies.
- **National Science Foundation (NSF) Engineering Directorate** – Funds nuclear materials and energy conversion research.
- **Private Sector Investment** – Venture capital from energy technology funds and corporate partners in nuclear and semiconductor industries.

International Funding Sources

- **Israel Innovation Authority** – Provides funding for Israeli-led technology collaborations.
- **Horizon Europe (EU Program for Research & Innovation)** – Supports transnational nuclear and energy innovation.
- **Bilateral US-Israel Energy Center (BIRD Foundation)** – Facilitates joint US-Israeli R&D initiatives.
- **International Atomic Energy Agency (IAEA) Research Grants** – Supports innovative nuclear power research.

7. CONCLUSION

This research proposal aims to establish the feasibility of **Direct Conversion Reactor Technologies** (HLEC & TPV) at MW-scale power levels. If successful, this R&D effort could lay the groundwork for an **entirely new class of nuclear power generation**, offering **high efficiency, compact design, and enhanced safety** compared to conventional reactors.

The collaborative effort between **US and Israeli scientists** ensures access to world-class expertise, and the project's **measured scope and budget ($50M-$75M over 3-5 years)** make it an attractive investment for government and private funding entities.

This study represents a **critical first step** toward the future of direct heat-to-electricity nuclear conversion. If scalability is confirmed, the next logical phase would be the conceptual design of a full-scale Direct Conversion SMR for commercial deployment.